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# ***JPRS Report***

# **Science & Technology**

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***CHINA: Energy***

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# Science & Technology

## China: Energy

JPRS-CEN-90-006

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### January Energy Figures Released

40100036A Beijing CEI Database in English 20 Feb 90

[Text] Beijing (CEI)—Following is list of China's total output of primary energy production in January, 1990, released by CSICSC [China Statistics Information Consultancy Service Center]:

Item	Unit	1/90	P/C over 1/89
Total output	(10,000t of standard coal)	7200	-2.5
A. Raw coal	10,000t	7168	-3.6
Of:			
Planned	10,000t	3802	-0.7
B. Crude oil	10,000t	1152.8	0.7
C. Natural gas	100 m cm	12.82	6.7
D. Generated power	(100 m kWh)	479.0	7.0
Hydropower		65.0	-4.5
Thermal	(100 m kWh)	413.6	9.0

### Energy Targets To Be Met by 2000

40100035A Beijing CHINA DAILY in English  
15 Mar 90 p 2

[Article by Huang Xiang]

[Text] The major State Council energy production targets for the year 2000 are certain to be met, Huang Yicheng, Minister of Energy Resources, said yesterday.

According to the plan, the Ministry of Energy Resources should produce 1.4 billion tons of run-of-the-mine coal, 200 million tons of petroleum, 30 billion cubic metres of natural gas, and 1.2 trillion kilowatt hours of electricity including 30 billion kilowatt hours from the nuclear sector.

"The energy industry has beaten the major State targets for the Seventh Five-Year Plan period (1985-1989), and we are making concrete efforts for the next ten years," said Huang, who spoke at a press conference in Beijing.

He said that the Ministry has decided to strictly control the coal market during the next two years.

Measures will include State control over coal prices, coal dispatching, transportation and allocation.

The central government blamed a disordered coal market for much of the country's power shortages, which have forced many enterprises to close down or operate below capacity.

"The Ministry has basically provided enough coal for industrial consumption, but many provinces keep complaining of a power strain. Besides a nationwide overheated economy, there are many scandals in coal market," said an official from the State Planning Commission.

At present the Ministry controls only some coal prices in an effort to establish a more market-oriented energy supply. But now some experts have blamed that policy for rampant official profiteering, which takes advantage of the price difference between controlled and uncontrolled supplies.

Huang said a ceiling price has been set for this year and he expected a unified price system for the whole industry by 1991.

To fulfill the State quotas for 2000, he said more mechanization will be encouraged in the power industry.

Currently only one quarter of the State-run mines are fully mechanized and they provided 40 percent of China's 1 billion tons of coal last year. The mechanization level is known to be much lower among locally or individually-run mines.

"We intend to double the mechanization level in the next few years," he said.

Huang also said that the State Council is planning the country's third nuclear plant "in a coastal place not far away from Jinzhou" in Liaoning Province.

"Negotiation is still going on with the Soviet Union concerning the importation of two 1-million-kilowatt generating units through barter trade," he said.

Huang disclosed that the central government is considering the expansion of Qinshan Nuclear Power Station in Zhejiang Province.

The Qinshan plant, which is due to go into operation by year's end, is designed entirely by Chinese scientists, who regard it as more for research than for practical use.

Huang said some other power-strained coastal provinces are also considering nuclear plants in their locality.

### Nation's Current Energy Situation Probed

906B0027A Beijing ZHONGGUO XINGZHENG  
GUANLI in Chinese 16 Nov 89 pp 2-5

[Article by Zheng Fa [6774 3127], Ministry of Energy]

[Text] Whether or not the strategic goals proposed by the party Central Committee for the economic development for the rest of this century can be achieved depends to a large degree on how well the energy problem can be solved. It is therefore important to delineate the reality of energy resources and the situation of energy production in China, to analyze the reasons for energy shortages and to propose effective measures.

### I. A Brief Analysis of China's Energy Reserves

In national pronouncements in the past, China was only described as having a large territory and rich resources; only very rarely were the resource distribution and development potential analyzed. The absolute quantities of the natural reserve of energy and material resources

were often quoted, but the relative resources per capita were often ignored. In the case of coal, for example, the verified reserve is quite large but the quantity of developed and exploitable coal is not very large. Also, the distribution of coal is very uneven, with high concentration in Shanxi, Shaanxi, and western Nei Mongol. High quality coal and exposed coal reserves are relatively low. According to 1987 statistics, China's coal production was the largest in the world, but the output per capita was lower than the average per capita output of the world. The per capita coal reserve of the world is 211.6 tons while in China this figure is 162.84 tons. In China the geological reserve of oil and natural gas is not great. The recoverable reserve of crude oil in China ranks ninth in the world, but a large fraction of that are dense oil and condensed oil that are difficult to recover. If new reserves are to be found, the degree of difficulty increases rapidly and so does the cost for prospecting. The survey investment for verifying 100 million tons of oil was 370 million yuan in the Fifth 5-Year Plan and 510 million yuan in the Sixth 5-Year Plan. It should also be noted that the per capita petroleum resources of the world is 18.4 tons but it is only 2.4 tons in China; the ratio is 1:0.13. According to the 1988 world petroleum statistics reported in West Germany recently, China was ranked fifth in both oil consumption and production, but the per capita figures were among the last. Although China has abundant water resources with 380 million kilowatts, the resources are distributed mainly in industrially backward and isolated northwest and southwest regions. Due to difficulties in development, less than 5 percent of the water resources were developed. Problems with population relocation and long distance power transmission must also be resolved before water resources can be fully utilized. China's power generation capacity has reached 120 million kilowatts, but the per capita electric power is very low. The 1987 data showed that the per capita electric energy in China was 466 kilowatts per person per year. In contrast, this figure in the United States is 10,938 kWh per person per year and in Japan it is 5,685 kWh per person per year. In China the per capita electric power is 0.1 kW per person, but in the United States and in Japan they are respectively 3 kW per person and 1 kW per person. Even in the year 2000, China's per capita electric power will be no greater than 0.2 kW per person, which is less than that in India.

In short, there is no lack of energy resources in China and the industrial energy output is also great; however, the per capita quantities are very small. The distributions of coal, oil, natural gas, and water resources are nonuniform, which make the development quite difficult. In China the per capita energy consumption is only about one-third of the world average and the utilization rate of energy is also low. These are the strengths and weaknesses of China's energy picture that is unique to China.

## II. Supply and Demand in the Energy Industry

The production and demand situation of the energy industry in China for the present and for some time to come may be summarized as follows: production will

exceed quota year after year but will not sustain for the long term, shortages will last and supply will be overwhelmed by demand.

Since the 3d Plenum of the 11th Party Central Committee, China has been developing the capital construction and production of its energy industry. From 1978 to 1988, the primary energy output increased from 627.7 million tons of standard coal to 957 million tons of standard coal, at an average annual rate of growth of 4.3 percent. The production of raw coal increased from 618 million tons to 980 million tons and oil increased from 104 million tons to 137 million tons. In the last 10 years China exported 200 million tons of crude oil and created \$32 billion of foreign exchange. Within this 10 years the electric power production more than doubled, generator capacity increased from 57.12 million kW to 115.50 million kW, and the electric energy output increased from 256.5 billion kWh to 545.0 billion kWh. These achievements of the energy industry provided strong support for the rapid development of the national economy and the reform movement.

After exceeding the 1988 national quota, China's energy industry continued to grow in the first half of 1989. As of the end of June, the raw coal output in China has already approached 480 million tons—8.84 percent higher than the same period last year—and the total output this year may break the billion ton mark. Crude oil production in the same period has reached 67.53 million tons, or 48.59 percent of the annual goal. The natural gas output was 7.2 billion cubic meters (51.4 percent of the annual target) and the electric energy production was 276.8 billion kWh, 5.25 percent higher than the same period of last year.

There have been major advances in energy construction in recent years. The electric power industry has been producing 10 million kW of generators each year over the last 3 years. In 1988 the uniform distribution coal mines increased their production by 30.90 million tons, a record in history. The petroleum industry increased its crude oil production ability by 15.767 million tons and its natural gas production by 1.163 billion cubic meters, both greatly exceeding the targets for the year.

Even though the production of coal, oil and electricity has been exceeding the production targets, China's shortages in energy supply are still getting more severe. Reports show that China now needs 30 million tons more coal, 10 million tons more oil, and 160 billion kWh more electricity and more than 25 percent of China's energy production facility are inefficient. Compared to a few years ago, China's energy shortages are getting worse. First, regional shortages have developed into nationwide shortages. Second, shortages in electric power have turned into shortages in oil and coal. Third, there is a vicious cycle between different energy forms. Shortages in electricity affected the production of coal and oil, and shortages in coal and oil in turn impeded the production of electric power and capital construction. Imbalances within the energy industry have aggravated

this cycle. In the Sixth 5-Year Plan, the growth in primary energy and electric power had a ratio of 1:1.05, which manifested as a moderate supply of primary energy but a short supply in electric energy. During the first 3 years of the Seventh 5-Year Plan, the growth ratio of primary energy to electric energy became 1:2.61, leading to shortages in coal and oil and a shortage of coal for electricity production. Fourth, the across-the-board shortage of energy will continue for some time yet. This can be attributed to the following four reasons. First, the investment on energy construction clearly slackened off; second, an overall reform of the entire energy price system takes time; third, production forces in an overheated economy caused shortages in certain areas; and fourth, rapid increases in consumer appliances and motorized vehicles fanned the fire of energy demands.

### III. Solution To Alleviate the Energy Shortage

In order to alleviate the shortages in energy, we should take the following measures:

#### 1. Reach an Agreement and Firmly Establish the Strategic Position of the Energy Industry in the Economic Development

It is clear in China's path of economic development that energy, first and foremost electric energy, is the major limiting factor in today's economic development and in the future. This is the law of economics. The wild swings of the pendulum in the history of China's energy industry, especially the 19 years of electric power shortage, were the punishments for violating this law of economics. Unfortunately, there are still some that did not learn the lesson; controversies still exist today. For example, some argue that if the economy overheats with energy shortage, wouldn't it overheat even more without energy shortage? Based on this kind of thinking, they propose to limit the rate of development of coal and electric power. This is obviously "stopping eating altogether on account of a hiccup." There are also people who believe that the cause of energy shortage is a lack of transportation power; they therefore advocate "determine the development of coal by transportation, and further determine the development of electric power by coal." This approach is like cutting off the toe to fit the shoe. If these erroneous perceptions are not eliminated, they will eventually affect the long-term stable development of the energy industry and the national economy. Fortunately, the Ministry of Energy was established last year to administer the energy profession. Based on the energy and material resources and the unique situation in China, the fundamental policy, mission and goal of energy development have been established. Also, a medium-term energy development plan was proposed to serve as the scientific basis for unified perception. Recently Comrade Deng Xiaoping discussed the economic problems in China and particularly stressed that "I am all for a stronger industrial and agricultural base. Basic industries are no more than raw material industry, transportation, energy and so forth. Investments in these areas should be increased and sustained for 10 to 20

years; basic industries must be strengthened even if we have to borrow money. This is also openness; we should be bolder in this area since there will not be great errors. Many other things will happen if we develop some more electric power, railroad, highway, and shipping." Deng's comment is not only a summary of the past experience, but is also a guidance and foresight of the future economic development. We must first unify our understanding under these important strategic thoughts and coordinate our efforts, then, there will be a premise for alleviating the energy shortage.

#### 2. Adjust the Development Speed of the Energy Industry and the National Economy

Before the Fifth 5-Year Plan, the average rate of energy growth in China was 10 percent. During the Fifth 5-Year Plan, the growth rate dropped sharply to 5.5 percent. Because of the reform policy in the Sixth 5-Year Plan, the energy growth rate increased to 6.1 percent. After entering the Seventh 5-Year Plan, the real growth rate in the first 3 years was only 3.8 percent. On the other hand, contrary to the obvious downward trend of the energy growth rate, the total value of industrial and agricultural production increased year after year. In the fifth period, it was 8.1 percent; in the sixth period, it went up to 11 percent; during the seventh period it grew at a rate of 14.8 percent and in 1988 it further went up to 16.8 percent. Civilian usage of electric power was increasing at a high rate of 20.3 percent. Obviously a mere 3.8 percent growth in energy is a drop in the bucket in meeting the consumption demands of a rapidly expanding economy and civilian usage of energy. This is the fundamental reason for the energy shortage. Based on foreign experience and unique situations in China, the elastic coefficient for energy must be 0.5 or more, and the elastic coefficient for electric power should be about 1.0. In other words, if the average rate of growth in energy by the year 2000 is 3.5 percent, then the rate of growth of the industrial and agricultural value of production cannot exceed 7 percent and the growth in electric power should be more than 7 percent. Moreover, in planning the national economy, these three quantities should have the proper mix and fluctuate synchronously. This would be a fundamental policy in alleviating the energy shortage.

#### 3. To Create More Sources and Cut Down on Consumption, and To Increase the Vigor and Lasting Power of the Energy Industry

Another important reason for the energy shortage is the low level of investment on the energy industry over the long run. The "sources" to create are primarily the investments on energy. During the Second 5-Year Plan period the energy industry received as much as 17 percent of the total investment, the level dropped to 9.1 percent during the Sixth 5-Year Plan and further down to 8.9 percent during the first 3 years in the Seventh 5-Year Plan. Moreover, the rate of depreciation in the energy industry is too low and new equipments are

difficult to obtain; as a result, even the simple reproduction is becoming hard to maintain. It should also be reminded that the energy industry was usually hit the hardest in every economic adjustment in the history of the People's Republic. During the 3 years of adjustment beginning in 1963, the level of investment on energy dropped to 12.77 percent, which dropped further to 8.5 percent during the 1982 adjustment. In the recent consolidation and reform, reason has it that more investments should be made on the tight energy supply, but in practice the investments on energy construction were actually suppressed. The electric power industry was particularly singled out for reduction, which made an overloaded energy industry face even greater difficulties. Therefore, the first thing to do is to increase the investment on the energy industry in the national budget based on the principle that the growth of the energy industry should be proportional to the development of the national economy. Investment on coal should be increased at least 3 billion yuan per year and the investment on electric power by the state should be at least 40 percent of the total investment on the electric power. The state's technology reform loan to the energy industry should not be lower than the fraction on the capital construction. Next, a coal development fund should be established and the electric power and petroleum construction fund should be strengthened in order to compensate for the inadequacy in the construction investments. For petroleum, natural gas and coal, the export foreign exchange should be used to pay the interests on the foreign loan. Third, the rate of depreciation and maintenance fee should both be increased. Finally, in order to speed up the exploration work of the energy industry and to increase the energy reserve, an exploration fund must be established and the energy resources must be used with compensation.

Another meaning of "creating sources" is to put the energy price in order as soon as possible and to turn around the deficit situation in the energy industry. The energy price, set too low and not adjusted for too long, has been another economic factor contributing to the energy shortage. Coal has been losing money for many years, petroleum and natural gas have been in the red since 1988, the electric power industry is on the verge of sliding into a widespread deficit, and the nuclear industry is in the difficult period of transferring from the military to the civilian sector. The grave result of having prices that do not reflect the value is to cause a general loss of vigor in the energy productivity. The first thing to put into practice should be to compute the prices of electricity, coal and oil based on interest paying ability to recover the investment. In the meantime we recommend lowering the tax rate for the energy industry and waiving the tax for using farming land, the tax for using city and town land, and the payment to the energy and transportation construction fund. Only after the price structure is put into order can the energy industry acquire the vigor and lasting power for development.

"Cutting down on consumption" is very significant for alleviating the energy shortage. The per capita energy resource utilization rate and energy production in China

are among the lowest in the world, but the energy consumption per unit value of production is quite high. Therefore, conservation and limiting irrational energy consumption should be basic national policies. The energy industry should especially lead the conservation effort. The Ministry of Energy has made conservation the fundamental guideline and basic thought in its near-term work priority and mid-term plan. Recently, the Planning Council of the State Council proposed the 1989 conservation target and called upon the nation to conserve 30 million tons of standard coal. This includes reducing electric power consumption by 9 billion kWh, reducing processed oil consumption by 800,000 tons, a 3 percent reduction in coal consumption from the 1988 level per 10,000 yuan of production value, that is, a reduction from 5 tons to 4.85 tons. Policies and regulations for energy conservation should be established as soon as possible in order to ensure the implementation of the energy conservation measures and to cut down irrational usage of energy.

#### **4. Make Policies That Favor Energy Development and Help the Energy Industry To Get Over the Difficulties**

The most effective among the proposed schemes to alleviate the energy shortage are to establish industrial policies conducive to the development of the energy industry and to adjust the industrial structure to restore balance. This is particularly true in the early phase of the commodity economy development. At the present time the policies should favor the energy industry to ensure its steady development. High priority support of the energy industry relies on policy. Specific policies should be established for investment, price structure, tax, finance, loan, conservation, and foreign trade. Based on the situation in China, policies should be made for the development and integrated utilization of the energy resources, village energy sources and new energy development, and the protection of the environment. With this series of protective and supportive policies for energy development, plus the efforts of the energy industry and the various measures described above, the shortage in energy will be gradually alleviated. With a greater development of the energy industry, a steady and long-term development of the national economy and the energy consumption needs of the nation will be ensured.

#### **Successes Reported for Many Major Energy Projects**

906B0042B Beijing RENMIN RIBAO in Chinese  
20 Jan 90 p 1

[Article by RENMIN RIBAO reporter Lu Mu [7627 3668]: "New Achievements in Key Construction in China, New Production Capacity Added in Energy and Communications"]

[Excerpt] I learned from the State Planning Commission that during administrative rectification and intensified reform, the pace of key construction in China has accelerated and new achievements have been made. Wholehearted cooperation in all areas overcame capital shortages, materials shortages, and other problems to add much new

production capacity in the energy resources, communications, posts and telecommunications, primary raw materials, and other sectors in 1989.

The coal industry placed 36 large mines into operation, including Dongtan at Yanzhou in Shandong, the No 2 mine at Panji in the Huainan Bureau, Weijiadi in Gansu, and others for an addition of 24.95 million tons in new raw coal extraction capacity, 102.3 percent of the annual plan. Ten large coal washing plants were completed, including Yanzi Shan at Datong, Qianjiaying at Kailuan, and others, for an additional 18.7 million tons in new coal washing capacity, 145 percent of the annual plan.

Projects completed and placed into operation in the electric power industry include 57 large and medium-sized generators with a capacity of 8,050 MW, including the first 600 MW power generator manufactured in China, equal to 101.5 percent of the annual plan. Including small generators, the total addition to power generation capacity was 8,708.3 MW. China's first ultrahigh voltage DC power transmission line (Gezhouba to Shanghai) has completed single stage debugging tasks.

There was an addition of 16 million tons in petroleum extraction capacity, equal to 133.3 percent of the annual plan. Daqing, Shengli, Liaohe, Zhongyuan, Xinjiang, and other key oil fields exceeded construction plan quotas in 1989. [passage omitted]

### Hidden Potential in the Energy Industry Explored

906B0042A Beijing JINGJI RIBAO in Chinese  
2 Jan 90 p 2

[Article by JINGJI RIBAO reporter Xie Ranhao [6200 3544 3185]: "Figures and Examples Illustrate Energy Industry Potential"]

[Text] Like other sectors, China's energy resource industry now has a substantial foundation after 40 years of construction, especially after reform, opening up, and development over the past 10 years.

However, it must be noted that rapid developments in S&T mean that there is still substantial potential in the energy resource industry in labor productivity, materials consumption, construction schedules, and other areas, both in comparison to the advanced nations and comparing advanced enterprises and backward enterprises in the same sector within China. Some sectors still have not attained the best historical levels in certain indices.

The data: In the coal industry, full-staff productivity per worker in China's "national team," unified distribution coal mines, is 1.092 tons. The highest, 4.72 tons, is at Jincheng Mine Bureau. However, it is less than 1 ton in 30 percent of our mine bureaus. Average efficiency in the main coal producing foreign nations is more than 3 tons. It is 16.28 tons for shaft mines and 40 tons for open-cut mines in the United States. Average yearly coal output from fully mechanized mining teams in China's unified distribution coal mines is 520,000 tons. The highest is 1.8 million tons

and the lowest is only about 200,000 tons, so they are not keeping up with output from top-class mining in Shaanxi within China. Moreover, the figure in foreign countries is generally above 1 million tons. The highest is the (Yangban) work face in Australia which produces 3 million tons of coal annually.

The electric power industry: China's 1,000 MW thermal power plants generally employ over 1,500 people. The comparatively advanced 700 MW Huaneng Dalian Power Plant employs 500 people. The basically identical Matsushima Power Plant in Japan, however, has less than 300 people. Average coal consumption for power generation in China's 6 MW and larger thermal power generators is 431 grams of standard coal per kWh. This amount is 320 grams in the Soviet Union. Water consumption indices in China's 1,000 MW thermal power plants are 1.4 to 1.6 cubic meters per second, but West Germany uses 0.6 to 0.8 cubic meters. The construction schedule for thermal power plants in China usually takes 36 months to place a 200 or 300 MW generator into operation and the quickest takes just 24 months. The Soviet Union and Japan usually take 28 to 29 months.

Examples: The plant site chosen for Xinjiang's Manas Power Plant was not in the coal-producing eastern suburbs of Urumqi City but was instead at Manas, over 130 kilometers from Urumqi. The initial reason for this was that no water was available in the eastern suburbs of Urumqi City. The relevant experts felt that adopting a program to use pipelines to bring in water would reduce investments and operating costs substantially.

Beijing's Shijing Shan Power Plant, with an installed generating capacity of 600 MW, had an estimated budgeted cost of 540 million yuan. The fear now is that it may be about double this amount. There are materials price factors involved here, but as the relevant experts have pointed out, "waste certainly exists."

The No 1 Mine at Santaizi in Liaoning's Tiefert Mine Bureau has a yearly coal production scale of 1.5 million tons and went into operation in 40 months. Daqiao Mine in Shenyang Mine Bureau, in contrast, has a yearly coal production scale of 750,000 tons and took 95 months to build. Panyi Mine in Huainan Mine Bureau has a yearly coal production scale of 3 million tons and took 149 months to build.

Xin'an Jiang Hydropower Station was the first large-scale hydropower station built in China in the early 1960's. It has an installed generating capacity of 600 MW and took just 3 years for its first generator to go into operation. It usually takes 6 to 8 years now.

It is easy to see from these figures and examples that we have considerable potential:

In this economic readjustment, the energy resource industry is a basic industry which should make great efforts to strengthen and accelerate development. The state should increase its investments. No coal mines, power stations, or oil fields can be built without money. However, we must also note that China is still relatively

poor and relying on the state to make large increases in investments is unrealistic now and for some time into the future. For this reason, Minister of Energy Resources Huang Yicheng [7806 3015 6134] has emphasized repeatedly that during administrative rectification, leaders at all levels of the energy resource system should expend 90 percent of their efforts on "looking inward, exploiting potential" and work to manage well, use existing capital, equipment, manpower, and materials well, and exploit potential within all sectors of the energy resource investment and within enterprises.

How can this potential be exploited? The relevant experts feel that previous practice shows that we must do good work in these areas:

1. Make reducing construction schedules for energy resource projects the breakthrough point for using existing capital well. This can conserve construction expenditures and lower project construction costs, and it can result in a relative reduction in the scale of construction, reduce capital tie-ups, enable earlier starts on project construction, earlier startup, and produce benefits more quickly, and it can enable the recovery of principal and interest ahead of schedule. An example is the two 350 MW imported generators at Huaneng Dalian Power Plant. It took just 24 months from the start of construction to startup for the first generator, about one-third less time than the average construction schedule in China.

2. Improve the health of existing equipment and achieve safe and stable high output. An example is China's largest thermal power plant, Jianbi Power Plant in Jiangsu with an installed generating capacity of 1,625 MW. Previously, it was only capable of producing 600 to 700 MW in output. In 1989, after the Ministry of Energy Resources organized forces to provide focused assistance, it was able to produce 1,200 MW in output even though it still used existing manpower and equipment.

3. Reinforce first-line guidance of production. The direct guide of the first line in enterprises is the team leader. His quality plays a decisive role in safe production and labor efficiency. This is especially true following gradual modernization of means of production. If the team leader lacks specific cultural and S&T knowledge, it is very hard for him to manage and use things well. An example is the experiment conducted in the No 1 fully mechanized mining team at Xiaonan Mine under Liaoning's Tiefa Mine Bureau which made technical cadres team leaders. The result was that yearly raw coal output in this team rose from 750,000 tons in 1988 to 1.2 million tons in 1989.

4. Do good planning and design. An example is the experiment with a joint venture for coal and power conducted by the Ministry of Energy Resources at Yimin He in northeast China. From the start, the project implemented unified design, unified organization and

construction, and unified administration and management of its open-cut coal mine and power plant. Estimated savings as a result of this implementation are a 5 to 10 percent savings in construction costs and a 10 percent reduction in operating costs.

### **Coal-to-Gasoline Conversion Called Major Technological Breakthrough**

906B0033A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 10 Dec 89 p 1

[Article by Zhang Tianding [1728 1131 1353] and Hao Baoping [6787 0202 1627]: "Successful Conversion of Coal to Gasoline"]

[Text] One of the key national technical projects in the Seventh 5-Year Plan, the "two-stage hydrogenation of carbon-monoxide gasoline synthesis" pilot plant was successfully completed by the Shanxi Institute of Coal Chemistry of the Chinese Academy of Sciences and by Daixian Chemical Fertilizer Plant after 4 years of effort. The 80-100 ton/year intermediate experimental line has been in stable operation for over 1,600 hours and has synthesized approximately 6 tons of gasoline better in quality than 80-grade gasoline.

Coal is abundant, while petroleum is relatively scarce in China. The shortage of gasoline is affecting transportation, as well as industrial and agricultural production. It is strategically significant to produce gasoline from coal. The two-stage hydrogenation of carbon-monoxide gasoline-synthesis technique involves the production of synthetic coal gas in a synthetic gas furnace with scrubbed anthracite. It is then passed through two reactors, one with an iron-based catalyst and the other with a molecular-sieve-type catalyst, to produce gasoline and other by-products. This technology has a simple flow chart and a high yield for high-quality gasoline. It can be easily scaled up for industrial production. In addition, based on market demand, it can produce other petrochemical products such as coal gas, diesel gas, fertilizer and waxy hydrocarbons while gasoline is being produced to further reduce its cost.

This project has been certified by experts who believe that it has met all technical objectives specified in the Seventh 5-Year Plan. It is the first such project in China and is comparable in technical level to similar units abroad. It has a bright future and will have positive impact on encouraging areas with more coal and little oil to utilize their coal resources to the fullest extent—speeding up coal conversion, alleviating fuel shortages and utilizing by-products from small nitrogen-fertilizer plants. The Chinese Academy of Sciences and the Science Commission of Shanxi held a "preliminary feasibility demonstration meeting on co-generation of coal-derived synthetic fuel and coal gas" a few days ago. Experts believed that it is feasible to build a 2,000-ton-a-year test facility at the Second Fertilizer Plant in Jingcheng, Shanxi, and recommended that the relevant department proceed with the plan.

### Energy Industry Growth: Stress on Fossil-Fuel-Fired Power

906B0033B Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 1 Jan 90 p 3

[Article by Wei Lin [7279 2651]: "Energy Industry Needs More Input To Grow"]

[Text] Beijing (ZHONGGUO XINWEN SHE)—As a vital basic industry, how can the energy industry bring the national economy to a track of sustained growth? Minister of Energy Resources Huang Yicheng has the following comments.

Energy resources are abundant in China. First is coal. We have a known reserve of over 860 billion tons. Next is hydropower. Approximately 380 million kW of hydropower remains to be developed. However, energy resources are extremely unevenly distributed in China. Eastern developed regions have very little energy resources. The average energy resource per person is very low and there is a serious shortage of capital to develop it. Also, due to poor management, the utilization rate of energy is also very poor. These are the basic advantages and disadvantages of the energy picture in China today.

In response to our current situation, the Ministry of Energy has presented the basic guideline, development strategy, and policy and measures for the energy industry in the near and mid-term based on the second-phase economic growth objectives to be accomplished by the end of this century. The basic thoughts are:

—Take full advantage of the abundance of coal in China by pouring in more investment to speed up development in this area. The overall arrangement is to first focus on coal development in Shanxi, Shaanxi, and western Inner Mongolia, especially the Dongsheng coal field in Shenfu where the reserve is estimated at over 200 billion tons. The key is to build roads in these areas to transport coal. Other projects include stepping up the development of brown coal in the four leagues in Inner Mongolia and the coal in eastern Heilongjiang and Liaoning, and strengthening the development of coal in eastern regions such as Shandong, Anhui, Yongcheng in Henan, and in Yunnan and Guizhou. We have to minimize the transportation of coal from west to east and from north to south. In addition, we will give priority to develop open-pit coal mines.

—In the area of fossil-fuel-fired power, new thermal power plants must use high-efficiency units. We must develop super-critical units and gradually phase out medium and small units in order to conserve coal. On the other hand, we have to accelerate the development of hydropower. First in importance is to do a great job on the construction of large hydropower plants in the upper reaches of the Huang He, the main stream and tributaries of the Chang Jiang, the Hongshui He, and

the Lancang Jiang. Next is to build a number of medium-sized hydropower plants in areas with water resources but no coal.

—The key issue for the petroleum and natural-gas industry is to increase reserves. In addition to stabilizing existing oil fields in the east, we should explore oil fields in the west. We must continue looking for joint ventures with other countries to develop offshore oil, as well as enhancing our own prospecting capabilities.

—Developing nuclear energy is an important step to solve the energy crisis along the east coast. In this century, we want to control manufacturing technology for nuclear-power facilities. Basically, we will have the capability to manufacture facilities and equipment for 600-megawatt-level nuclear power plants to serve as a solid base for accelerated development of nuclear power in the next century.

Huang mentioned that the key to implementing the above strategy and achieving the objectives by the end of this century is an increase of investment in the energy industry. The policy toward collective investment in energy must be encouraged to continue and a coal-construction fund has to be established. We have to encourage the coal, electric power, and petroleum industries to take advantage of foreign capital. Gradually, the cost of energy must be adjusted to turn the industry around—to make it a profitable business in order to enhance its vitality.

### Breakthroughs in Heavy Mining, Power Generation Equipment

40100037E Beijing XINHUA in English 1632 GMT  
27 Feb 90

[Excerpts] Beijing, February 27 (XINHUA)—China has succeeded or made breakthroughs in development of nine out of the ten kinds of large technical equipment designated by the State Council as major national research projects for the Seventh Five-Year Plan (1986-1990).

The announcement was made here today by Zhang Xuedong, vice-minister of machinery and electronic industry.

According to Vice-Minister Zhang, opencast mining equipment with an annual capacity of 10 million tons has been developed. The equipment includes a 16-cubic-meter excavator, a 154-ton automatic unloading machine, a 310-millimeter drilling machine and a 320-horsepower bulldozer.

A breakthrough has been made in the development of large thermal power equipment. An imported generating unit with a capacity of 600,000 kilowatts has been installed and put into production at Pingwei Power Plant. Two imported generating units, each with a capacity of 300,000 kilowatts, have also gone into operation. China has been able to make more than 80 percent

of the parts for the 300,000-kilowatt generating unit and to make the large castings and forgings of the 600,000-kilowatt generating unit.

The second generation of Chinese 500-kilovolt extra-high voltage alternating power transmitting and transforming equipment has reached international technical levels of the early 1980s, shortening the gap in this field between China and the world advanced by 10 years.

The completion of the construction of the third stage of the Qinhuangdao Coal Wharf shows that China is able to build large coal harbors with an annual handling capacity of 30 million tons. [passage omitted]

The only one of the 10 heavy equipment projects whose development is still on the early stage is the hydropower generating unit for the power plant at the three gorges on the Yangtze River, which is still under discussion.

**Energy Ministry Improves Rural Power Supply**  
*40100039A Beijing XINHUA in English 1537 GMT*  
27 Mar 90

[Excerpt] Tianjin, March 27 (XINHUA)—The total power consumption in China's rural areas reached 192 billion kilowatt-hours last year, three times the 1978 figure.

A spokesman for the Energy Resources Ministry said this at a national working conference on electrification in China's rural areas which ended here today.

The spokesman said that over the past 10 years, power consumption in rural areas increased at an annual rate of 14 percent. And in 1989, 115.3 billion kilowatt-hours of the total consumption was used in rural and township enterprises.

China is an agricultural country. Some 850 million of its total population (1.1 billion) are living in the countryside.

The work force engaged in rural power supply totals 1.5 million. Electric power networks have reached 95 percent of China's counties and villages.

China has a total of 6.27 million kilometers of high-tension [and] low-tension lines in rural areas. Substations number 12,194 and the installed capacity of rural power stations totals 20.12 million kilowatts.

Since 1978, the state has invested 2 billion yuan (about 400 million U.S. dollars) on the improvement of electric facilities. [passage omitted]

### **Building 10 Million KW in Medium Hydropower Stations Before Year 2000**

906B0043A Beijing SHUILI FADIAN [WATER POWER] in Chinese No 1, 12 Jan 90 pp 3-5

[Article by SHUILI FADIAN Editorial Department: "Adapt to Local Conditions, Integrate Large, Medium, and Small Scales—Continue Working To Build 10,000 MW in Medium-Scale Hydropower Before the Year 2000"]

[Text] The year 1990 [as published] is the key year for administrative rectification and intensified reform in China. In this new year, how will China's hydropower construction continue to develop forward? According to SHUILI FADIAN's understanding of the situation from relevant departments, first, we will resolutely "take full advantage of China's hydropower resources and make accelerated hydropower construction a basic strategy for China's energy resource industry." In the current administrative rectification and structural readjustment, we should earnestly implement the "Policy Implementation Methods for the Energy Resource Industry (Provisional)," focus support on the electric power industry, give preference to developing hydropower, increase hydropower as a proportion of energy resources, and use at least 50 percent of electric power investments arranged by the state for hydropower. Despite definite problems in the economy in 1990 and insufficient state investments, total hydropower construction investments will not fall below 1989 levels to assure continued growth in hydropower construction. Second, we should continue to intensify reforms in survey and design, capital raising, construction, production and operation, and other areas during the administrative rectification to gradually match up and perfect them. Third, we should conscientiously adhere to the principle of adapting to local conditions, integrating large, medium, and small scales, and accelerating hydropower development. While concentrating forces to develop large key hydropower stations, we should also develop medium-scale hydropower stations in a planned and gradual manner. During the first third of December 1989, the Ministry of Energy Resources and State Energy Resource Investment Company held a Southern Provinces (Autonomous Regions) Medium-Scale Hydropower Conference in Fuzhou City. On the basis of the strategic idea of building 10,000 MW in medium-scale hydropower from 1989 to 2000 in regions of China with coal and power shortages, the conference analyzed situations and tasks, exchanged experiences, discussed policies, and clarified certain key and major issues in developing medium-scale hydropower. SHUILI FADIAN provides a focused report on this conference below.

#### **I. The Urgency of Developing Medium-Scale Hydropower**

There have been substantial developments in China's electric power construction in the 40 years since the nation was founded, but our electric power shortage is becoming increasingly acute and the energy resource

situation is extremely serious. The structure of primary energy resource production in 1988 was: raw coal 73.1 percent, petroleum 20.4 percent, hydropower 4.5 percent, and natural gas 2 percent. The structure of electric power production at present is: coal-fired power 71 percent, hydropower 20 percent, and oil-fired power 9 percent. In 1988, 25 percent of total raw coal output was used to generate power. This situation is very ill-adapted to China's current coal production, communications, and transport situations and medium and long-term plans. Looking again at the current hydropower construction situation, plan specifications for 1988 call for only 14,980 MW in large hydropower station construction and just 1,450 MW in medium-sized hydropower station construction, for a total of 16,430 MW. This falls far below the need to add 50,000 MW in new hydropower installed generating capacity in China before the year 2000 as envisioned in the state's medium and long-term energy resource plans. At the end of 1988, China's hydropower installed generating capacity was about 32,700 MW, 42.5 percent of it large-scale, 20.5 percent medium-scale, and 37 percent small-scale. This is like two big ends with a small middle. Moreover, medium-scale hydropower stations account for just 9 percent of large and medium-scale hydropower stations now under construction. For the past few years, economic construction in China has been in a period of readjustment and state finances are limited. The scale of investments in hydropower construction in 1990 can only be held at the 1989 level and there are definite restrictions to beginning construction of more large-scale hydropower projects. If we begin building them too late, it will be hard to complete startup and power generation tasks prior to 2000. For this reason, we must concentrate finances and manpower to combine construction of large key hydropower stations with building several medium-scale hydropower stations which have good benefits and produce results quickly according to previously formulated strategic plans in regions which have water but lack coal by relying on local forces in a planned and gradual manner to meet the urgent need for power for local economic development, reduce pressures on power supplies in large grids, free up electricity to guarantee the needs of key state enterprises, and improve benefits in key enterprises.

#### **II. Advantages of Developing Medium-Scale Hydropower**

1. Medium-scale hydropower has the advantages of being "short, simple, and quick," meaning that medium-scale hydropower projects are simpler, have shorter construction schedules, and produce results more quickly. Preliminary analysis of statistics shows that for the 69 medium-sized and 25 large hydropower stations built from the 1960's to 1980's, the unit investment power kW for medium-scale hydropower stations is 1,291 yuan and the construction schedule for power generation was 3.8 years, while the unit investment per kW for large hydropower stations was 1,103 yuan and the construction schedule for power generation took 7.9

years. If we look at unit investments per kW, medium-scale was 20 percent higher than large-scale, but if we look at construction schedules, medium-scale was 50 percent shorter than large-scale. Current investments require compensated utilization and repayment of principal and interest. Because medium-scale power station construction schedules are shorter and involve less interest, the price of power supplied to grids is generally somewhat lower than that from large hydropower stations, so they are better adapted to local capabilities.

2. Medium-scale hydropower has the advantage of being located in resource regions. South China has a shortage of coal resources but is rather rich in hydropower resources. Using hydropower instead of coal is one way to reduce the coal shortage. The 10 provinces (autonomous regions) participating in this conference shipped in a total of 30 million tons of raw coal in 1980. Net in-shipments were 53.19 million tons in 1988, an average yearly increase of 2.59 million tons, a frightening rate of growth. In contrast, these 10 provinces (autonomous regions) have 38,820 MW in medium-scale hydropower resources, 58 percent of the total in China. At the end of 1988, just 4,360 MW had been developed for a development and utilization rate of 12 percent, so there is still substantial potential. Medium-scale hydropower already developed generated 1.67 billion kWh of electricity in 1988, equal to 11.1 percent of the unified dispatching power output in grids in these 10 provinces (autonomous regions), which is equivalent to replacing 10 million tons of raw coal. This compensated for power shortages in the electric power system and replaced coal, so the role is apparent.

3. Medium-scale hydropower has the advantage of fostering local initiative. There is now considerable initiative to develop medium-scale hydropower in all areas. The reasons for this are: 1) Local economies have grown and their power use loads have increased. Simply relying on small-scale hydropower to meet the need for additional economic development is not sufficient, and there are urgent demands for continuing to develop small-scale hydropower and actively developing medium-scale hydropower. 2) Economic growth has increased the financial incomes of local areas and strengthened their economies, so they are certainly able to raise capital for building medium-scale hydropower. This is particularly true of the implementation of decisions of the 5th Plenum of the 13th CPC Central Committee regarding further administrative rectification and intensified reform, readjustment of the investment structure, strengthening the energy resource industry, and creating excellent conditions for accelerating the development of medium-scale hydropower. 3) After 40 days of development, technical forces and technical levels in all areas have risen substantially and they are capable of taking on medium-scale hydropower design and construction tasks.

### III. Primary Experiences in Developing Medium-Scale Hydropower

1. Unified planning and selection of optimum projects for development. Fujian Province, for example, has paid extremely close attention to hydropower development plans and preparatory work. Besides those now under construction, they have completed feasibility research and preliminary designs for 13 medium-scale hydropower stations with a total installed generating capacity of 761 MW, which basically can meet construction requirements for the Eighth 5-Year Plan. They adopted a method of several parts in raising funds for preparatory work, with the province arranging part, departments providing some support, local governments providing part, and design academies contributing a part. Fujian Province included medium-scale hydropower development in its provincial energy resource plan and made needs and possibilities the basis for integrating the short term and long term, making unified arrangements, selecting optimum projects for development, and building in groups to ensure sustained and stable development of medium-scale hydropower.

2. Raising capital from many parties, integrating to build power. A main factor behind the relative slowness in medium-scale hydropower development is a shortage of construction capital. Thus, broadened capital sources are an important guarantee for construction. Over the past few years, all areas have intensified reforms and adopted capital raising methods which extend beyond their region, integrate many sectors, and involve many channels, many layers, and many patterns in taking the route of raising capital from many sources and integrating to build power, thereby gradually opening up the situation for raising capital for medium-scale hydropower. The basic story involves requisitioning an electric power construction fund, over-collecting energy resource and communications funds, "using power to develop power" capital, some capital in budgets, bank loans, issuing electric power construction bonds, enterprise investment shares, and so on. On this foundation they again raised capital from many sources to ensure construction capital. Fujian Province's Fancuo Hydropower Station (installed generating capacity 3 X 120 MW) is an example. It was built with capital raised by the local area and departments, with the Fujian Provincial Government providing specific preferential policies. Two generators have already begun generating power.

3. Implement new prices for new power. To ensure that the principal and interest are repaid, Fujian Province made repayment within 10 to 12 years of the principal and interest of the investment for capital raised to build medium-scale hydropower the basis for calculating

electricity prices. Electricity prices are calculated once each year and implemented after they are reported to the Provincial Materials Prices Department for examination and approval. Medium-scale hydropower stations which implement integrated grids are under unified dispatching by the provincial grid. Surplus electricity is purchased by the grid at a price and there is unified comprehensive accounting for electricity according to new prices for new power within large grids, with the grids acting as agents. In Guangdong Province, after medium-scale hydropower goes into operation, besides implementing new prices for new power, electricity prices with seasonal and peak-to-valley differentials are also implemented for power supplied to the provincial grid. During the wet season, peak power is 0.12 yuan per kWh and valley power is 0.06 yuan per kWh. During the dry season, peak power is 0.23 yuan per kWh and valley power is 0.07 yuan per kWh.

4. Adopting preferential policies. These are formulated by each province according to its own situation and authority limitations, and there are many varieties. Fujian, Sichuan, Hunan, and other provinces, for example, provide medium-scale hydropower with the same treatment after it goes into operation as they do for small-scale hydropower. It is exempt from the product tax for 3 years after going into operation and exempt from income taxes during the period of loan repayment. There are supplements of the "three types of materials" at parity prices. Medium-scale hydropower stations which provide comprehensive utilization benefits for water conservancy or which provide water for urban industries are exempt from the cultivated land occupation tax, and so on. These policies serve to provide substantial support to medium-scale hydropower.

5. Development-type resettlement arrangements are made. For the past few years, all areas have been exploring ways to make development-type arrangements for resettled populations in their arrangements for resettlement according to the principle of providing reserve support, going into mountainous areas, and local decentralized arrangements. This solved the housing problems of resettled persons and solved their problems of future production, development, and means of livelihood. According to the social and natural conditions of each area, land and crop compensation funds were utilized for a unified focus on and arrangement of development-type production projects, most of which were mainly labor-consuming cropping, breeding, forestry, agricultural sideline production and processing, and establishment of township and town enterprises tied to local resource conditions. This was well-received by the masses who were resettled. During the process of arranging for the resettled population, the leadership focused on and reinforced propaganda

and education work and conscientiously implemented population resettlement policies. They sought truth from facts in determining compensation standards for the resettled population and gained the understanding and support of local governments and masses for the resettlement arrangements. Arrangements for the resettled population went relatively smoothly, and the social results were rather good.

6. Reinforcing leadership and administration. The principle of those who invest in medium-scale hydropower being those who use the electricity and gain the benefits has actively encouraged departments, local areas, and enterprises to raise construction capital through many channels. Because they were capital-raising projects, the joint investors were extremely concerned with economic benefits and the pace of construction. Thus, the common concern of those raising capital was overcoming the ideology of eating from the big common pot in project construction and management, strengthening their concept of economic results, and working hard to conserve investments and reduce project construction costs. At Fancuo and Liangxian Hydropower Stations now under construction in Fujian Province, for example, the investing units organized a board of directors and established an administrative organ to manage power plant construction and operation to improve economic results. During project construction, they adhered to reform and implemented a bidding system or contractual responsibility system to select the best construction units, reinforce the economic responsibility system, strive to control estimated project budgets, and accelerate the pace of project construction. Practice shows that tasks were completed best in projects which implemented construction through contractual responsibility for investments. The construction schedules usually took slightly more than 3 years, which revealed the advantages of medium-scale hydropower in "short schedules, smooth progress, and producing benefits quickly." After the power stations were completed, they were connected to the grid for operation and they signed contracts or agreements with grid administration departments. The power stations served unified dispatching in the grids to ensure safe operation. The grids guarantee the reasonable rights of the investors and take advantage of the economic benefits of the power stations to encourage initiative in all areas to develop power.

On the basis of the present energy resource situation and tentative plans for electric power development, there are broad prospects for developing medium-scale hydropower. If we conscientiously adhere to the spirit of the 5th Plenum of the 13th CPC Central Committee, continue to implement the principle of reform and opening up, unite in cooperation, and struggle hard, we certainly can overcome problems in our advances. Medium-scale hydropower construction in China certainly will have gratifying achievements and make new contributions to alleviating our shortages of coal and power.

## Exploiting Advantages of Sichuan's Hydropower Resources

### Hydropower Construction

906B0052A Beijing SHUILI FADIAN [WATER POWER] in Chinese No 2, 12 Feb 90 pp 6-7

[Article by Zou Guangyan [6760 1639 0917], deputy director of the Sichuan Provincial Planning and Economics Commission: "Take Advantage of Hydropower Resources, Accelerate Hydropower Construction in Sichuan"]

#### [Text] I. Introduction

Sichuan Province is a province of China which is rich in resources. In Sichuan Province's energy resource structure, coal accounts for 19 percent, natural gas 1.2 percent, petroleum 0.1 percent, and hydropower 79.7 percent. Sichuan Province is richly endowed with hydropower resources and holds first place in China. Surveys show that Sichuan has theoretical hydropower resource reserves of 150,000 MW, equal to 22.2 percent of the total for China. It has a developable installed generating capacity of 91,660 MW, 26.8 percent of China's total. Thus, we should take full advantage of Sichuan's hydropower resources and make accelerated hydropower construction the fundamental strategy for developing the energy resource industry in Sichuan.

#### II. Hydropower Resource Characteristics, Current Development Situation

Sichuan Province is not only the richest of China's provinces in hydropower resources. It also has these advantages which favor development: 1) The amount of water in most rivers is abundant and stable, and heads are large and concentrated. Natural heads on most major rivers like Jinsha Jiang, Yalong Jiang, the upper reaches of Min Jiang, and others exceed 2,000 to 3,000 meters, and many of their tributaries flow swiftly down steep slopes with heads of several hundred to 1,000 or 2,000 meters. Sichuan has a wet climate and substantial precipitation. The high mountainous area of west Sichuan has many snow-covered mountains, so the amount of water flowing in its rivers is abundant and stable, with only minor variations between wet and dry seasons within a year and from year to year. 2) There are over 1,300 large and small rivers densely distributed throughout Sichuan, including 380 rivers with a developable installed generating capacity of more than 10 MW where various types of large, medium-sized, and small hydropower stations could be built. Some 78 percent of Sichuan's developable hydropower resources are concentrated in the Jinsha Jiang, Yalong Jiang, and Dadu He river basins (abbreviated as the "Three Rivers") in west Sichuan, making it China's biggest hydropower resource base area. 3) Reservoir inundation losses are small and would have only minor effects on the ecological environment. Estimates are that an average of 130 mu of land would be inundated and 140 people resettled per 100 million

kWh of power output, just 34 and 35 percent, respectively, of the average figures for China as a whole. 4) Many hydropower stations planned for construction already have a definite foundation for communication with outside areas. Besides the Chengdu-Kunming and Neijiang-Yibin railroads which already extend into the "Three Rivers" region, all the primary river segments are accessible by highway. 5) The rock at several dam sites is integral and earthquake intensities are not strong, so they have rather good conditions for dam construction. Although capping strata at dam sites on some rivers are rather deep and geological conditions are relatively complex, these problems can be solved through scientific research. Medium-sized and small hydropower station dam sites have the favorable attributes of simple geological conditions and ease of construction. 6) The power supply distance is relatively nearby, with most power stations being just a few hundred kilometers from Sichuan's load centers (Chengdu, Chongqing, and other cities). They are about 1,000 kilometers from the central China region. Thus, medium-scale and small hydropower could provide local power supplies for counties and townships. Construction practice over 40 years has trained hydropower survey and design, scientific research, equipment manufacturing, construction, and operational management staffs which have good qualities, high standards, and are capable of fighting hard battles. All these things are favorable conditions for accelerating development of hydropower construction in Sichuan.

Since new China was founded, the concern of the party and government have brought substantial developments to hydropower construction in Sichuan Province. When the nation was founded in 1949, Sichuan's hydropower installed generating capacity was just 4.7 MW and yearly power output was 16 million kWh. After 40 years of construction up to the end of 1988, Sichuan Province's hydropower installed generating capacity had grown to 3,060 MW, equal to 50.4 percent of the total installed generating capacity in Sichuan. Yearly power output from hydropower was 13.1 billion kWh, equal to 44.1 percent of total yearly power output in Sichuan. Another 9,000 MW or so in hydropower installed generating capacity will be added by the year 2000 and hydropower output will reach 44 billion kWh. When this goal is achieved, the extent of hydropower development in Sichuan Province will only rise from the present 3.3 percent to 13.1 percent, so the hydropower resource utilization rate is still very low.

#### III. Adhere to Overall Principles for Energy Resource Work, Make Two Strategic Transformations in Electric Power

To alleviate the energy shortage and develop the energy resource sector, the overall principle for energy resource work in Sichuan Province formulated by the Sichuan Provincial CPC Committee and Provincial People's Government is: Make electric power the focus

and coal and hydropower the foundation, comprehensively develop power, coal, oil, and gas, and synchronize construction of coal, power, and railways. Resolutely combine development and conservation, resolutely integrate large, medium, and small-scale projects, conscientiously motivate initiative of central authorities, local areas, and enterprises, and with support from the state and participation by all the people of Sichuan, give preference to developing hydropower, develop thermal power to an appropriate degree, extract coal and natural gas in a planned manner, reinforce R&D on new rural energy resources and other renewable energy resources, strive to readjust the product structure and industry structure, increase the energy resource utilization rate, reduce energy consumption, strive to move from passivity to activity in Sichuan's energy resource industry, and make a strategic transformation from pernicious cycles to benign cycles.

Sichuan Province is now making two strategic transformations in the area of developing electric power. One is from combining hydropower and thermal power to a focus on hydropower, preference for developing hydropower, and suitable development of thermal power. The other is developing hydropower everywhere by centralizing forces to build more commercial power stations and using "self-construction, self-management, and self-utilization" to make large projects the key factor and medium-sized and small projects the foundation for integrating large, medium, and small scales. In construction deployments, Sichuan should first of all focus on developing large hydropower stations in the "Three Rivers" region to make accelerated development of "Three Rivers" hydropower resources the turning point for invigorating Sichuan Province's economy. Thus, we should first make Ertan Hydropower Station (installed generating capacity 3,300 MW) on Yalong Jiang the focus and begin building it in 1990 in a push to place it into full operation before 2000. We should begin now to push ahead with preparatory work for Baobugou, Jinping, Xiluodu, and many other key projects and try to make Baobugou Hydropower Station (installed generating capacity 3,300 MW) on Dadu He the next engineering project after Ertan, make the Jinping first cascade (installed generating capacity 3,300 MW) and Jinping second cascade (installed generating capacity 3,000 MW) hydropower stations the next engineering projects after Baobugou, and make Xiluodu (installed generating capacity 10,080 MW) and Xiangjiaba (installed generating capacity 5,000 MW) hydropower stations on Jinsha Jiang the key hydropower power source projects for "transmitting power from west China to east China" for the state. We should concentrate on building Tongjiezi (installed generating capacity 600 MW), Baozhusi (installed generating capacity 700 MW), and other hydropower projects now under construction and strive to make Tongzilin Hydropower

Station an engineering project to be built in synchronization with Ertan and make Zilanba Hydropower Station an engineering project to be built in synchronization with Baozhusi Hydropower Station to enable them to play a counter-regulation role in order to improve the comprehensive benefits of cascade development. While striving to focus on large key hydropower station construction, we should also push forward with construction of several medium-sized hydropower stations. Sichuan has already built nine medium-scale hydropower stations with an installed generating capacity of 755.5 MW and has eight under construction with an installed generating capacity of 270.1 MW. Plans call for trying to build 2,000 MW in medium-scale hydropower stations by the year 2000. In the near term, we should try to include Taipingyi, Dongxiguan, Tongtuo and other medium-scale hydropower stations with good conditions and complete preparatory work among projects for beginning construction and concentrate forces to develop a cluster of medium-scale hydropower stations on Baoping He, Nanya He, Mabian He, Wasi He, and soon to form a medium-scale hydropower base area. We should continue to focus on small-scale hydropower construction and rural trial electrification county work and strive to place 100 MW of local small-scale hydropower (excluding medium-scale hydropower) into operation each year to create more and more electrification counties.

#### IV. Policies, Measures, and Methods for Accelerating Hydropower Development

To accelerate hydropower development, Sichuan is now implementing and will implement these policies, measures, and methods: 1) Continue to implement the principle of "raising capital to develop power, shareholder management, using power to develop power, and rolling development" to encourage the raising of capital from many channels and at many levels to develop power. We should deregulate electricity prices and give those who develop power the ability to repay principal and interest to motivate initiative in the state, local areas, enterprises, individuals, and other areas. 2) Protect the rights of investors. All who engage in joint investments to develop power with Sichuan Province enjoy shareholder rights according to international practices on the basis of actual investment proportions, and power and profits are allocated according to shares. The period for repayment of investments in medium-scale hydropower stations is generally about 10 years after the first generator goes into operation. 3) Reinforce preparatory work, establish a preparatory work fund in Sichuan, carry out survey and design for river basin planning and power source sites in a planned and gradual manner, establish project archives, and place several hydropower projects with mature conditions and which can begin quickly in a reserve status. 4) Organize river basin development companies on the basis of river basins, use power stations as a start to enable rolling development and self-development. 5) Gradually reform the electric power management

system to adapt it to the new situation of many parties developing power. State Council member Comrade Zou Jiahua [6760 1367 5478] has pointed out that "In the electric power industry system, power plants and power grids should establish a new type of relationship in which power plants sell electricity to grids and grids sell power to users, with separate economic accounting for each. Power plants should establish independent accounting and responsibility for their own profits and losses with self-development and self-rolling to take the route of benign cycles. Hydropower should have even greater concern for this. Organize hydropower development companies according to river basins, use power to develop power, achieve self-development, and develop other projects in their river basins." Sichuan Province should conscientiously study and adhere to the spirit of this instruction.

To accelerate hydropower construction in Sichuan, we also should fight for state support and hope that they provide some slanted investments and preferential treatment in interest rates and loan repayment schedules.

All the people of China are now adhering to the spirit of the 5th Plenum of the 13th CPC Central Committee and continuing to implement the principle of administrative rectification and intensified reform. This is an excellent time to readjust industry structures and develop hydropower. We should be willing to begin some projects and stop others and to save some projects and abandon others to attract our limited capital toward basic industries, particularly hydropower. The leadership and help of the State Planning Commission, Ministry of Energy Resources, Ministry of Water Resources, State Energy Resource Investment Company, Huaneng Company, and other related ministries and commissions will bring greater, faster, and better development of hydropower construction in Sichuan.

### Overview of Medium-Scale Resources

906B0052B Beijing SHULI FADIAN [WATER POWER] in Chinese No 2, 12 Feb 90 pp 15-19

[Article by the Planning Office of the Chengdu Survey and Design Academy: "Overview of Medium-Scale Hydropower Resources in Sichuan Province"]

#### [Text] I. Overview

Sichuan Province in southwest China covers a total area of almost 570,000 square kilometers. The province has a complex topography with obvious rises and falls in terrain and substantial variations in elevation. Mountains cover 49.5 percent, plateaus 29.3 percent, hills 14.7 percent, and plains just 6.5 percent.

Sichuan's location in the western part of China's monsoon region subjects it to alternating influences of southwest monsoons and southeast monsoons. It has relatively abundant rainfall with annual precipitation of about 900 to 1,200 mm and perennial average precipitation of 1,040 mm.

Sichuan has many rivers, with 1,149 rivers covering basins larger than 100 square kilometers, 345 of them larger than

500 square kilometers and 19 larger than 10,000 square kilometers. With the exception of Hei He and Bai He at its northwestern boundary which flow into Huang He, the remaining 97 percent of its rivers are in the Chang Jiang Basin. The rivers have distant sources and flow for long distances. The river basins cover vast areas and are fully replenished by water sources. The amount of runoff is enormous, with perennial average runoff of about 310 billion cubic meters, one of the three major water sources for Chang Jiang Basin and equal to 11.6 percent of total runoff in China, putting Sichuan in second place.

Most of Sichuan's rivers originate in the plateaus and mountains of west and north Sichuan. They wind through high mountains with steep cliffs on both banks and sharp peaks obstructing them. They have enormous heads and flow swiftly, and they are extremely rich in hydropower resources. Sichuan Province has 150,000 MW of hydropower resource reserves, with a developable installed generating capacity of 91,660 MW and yearly power output of 515.3 billion kWh, about one-fourth the total in China and first place among all of China's provinces and autonomous regions. Besides the trunks of Jinsha Jiang, Yalong Jiang, and Dadu He which have the biggest concentration of large power station sites in China, there are medium-sized and small rivers throughout Sichuan which similarly contain extremely abundant medium-scale hydropower resource reserves.

Relevant data and statistics over the past few years show that Sichuan has 65 rivers on which medium-scale hydropower cascades could be developed. There are 227 medium-scale hydropower stations planned for them with a developable installed generating capacity of 14,900 MW and yearly power output of 85.1 billion kWh, about 22 percent of all of China's developable medium-scale hydropower resources, making Sichuan China's richest province in medium-scale hydropower resources.

The distribution of Sichuan's medium-scale hydropower resources is roughly divided by the trunk of Min Jiang, with less to the east and more to the west. Medium-scale hydropower resources in east Sichuan are located mainly on the trunk of Jialing Jiang and trunk and tributaries of Fu Jiang. Together, they contain a developable installed generating capacity of about 3,700 MW or 25 percent of all of Sichuan's medium-scale hydropower resources. West Sichuan, which includes the trunk of Min Jiang and various rivers to the west of it, is a region of concentrated medium-scale hydropower resources. It has a developable installed generating capacity of 11,200 MW or 75 percent of Sichuan's total. It includes Yalong Jiang with about 3,110 MW, Dadu He with about 2,860 MW, Min Jiang with about 2,090 MW, Qingyi Jiang with about 1,680 MW, and Jinsha Jiang with about 1,350 MW. Medium-scale hydropower resources on these rivers are located mainly on tributaries in the upper reaches of their trunks.

Figure 1 and Table 1 show the distribution of Sichuan's medium-scale hydropower resources and statistics on medium-scale hydropower resources.

Table 1. Statistics for Medium-Scale Hydropower Resources in Sichuan Province

Name of water system	Scope	Number of sites	Installed generating capacity (MW)	Yearly power output (billion kWh)	Percent of provincial total
Jinsha Jiang	Excludes tributaries of Yalong Jiang in other provinces	34	1,346	7.63	9.0
Yalong Jiang	Trunk and tributaries	38	3,114	19.14	22.5
Dadu He	Excludes tributaries of Qingyi Jiang in other provinces	45	2,862	17.20	20.2
Qingyi	Trunk and tributaries	25	1,677	9.78	11.5
Min Jiang	Trunk and tributaries excluding Dadu He and Qingyi Jiang	26	2,093	11.47	13.5
Jialing	Trunk and tributaries of Jialing Jiang, Qu Jiang and Fu Jiang	41	2,732	15.03	17.6
Chuan Jiang tributaries	Tributaries of Chuan Jiang other than those above	12	477	1.98	2.3
Other	Tributaries of Wu Jiang, You Shui and Ren He	6	601	2.90	3.4
<b>Total</b>		<b>227</b>	<b>14,902</b>	<b>85.13</b>	<b>100.0</b>

Notes: 1) Statistics in table refer to developable hydropower resources. 2) Percentages in table calculated according to yearly power output.

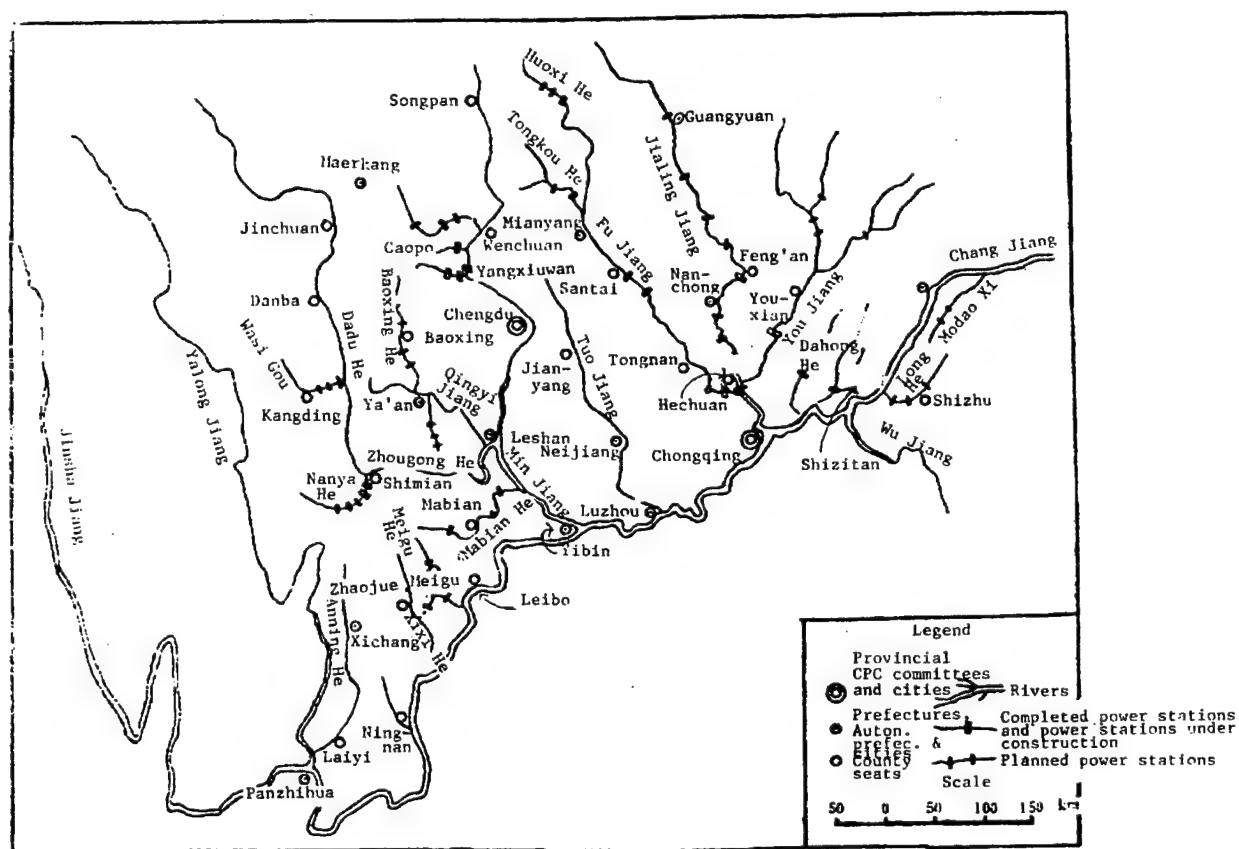


Figure 1. Simplified Diagram of the Distribution of Medium-Scale Hydropower Resources in Sichuan Province

## II. Brief Introduction to Plans for Focused Development of Rivers

Sichuan Province has quite a few rivers where medium-scale power stations could be built. This article will mainly provide a brief introduction to medium-scale hydropower with better development conditions and relatively concentrated resources which can be the focus of development in the near term, such as Nanya He, Wasi Gou, Meigu He (including water diversion from Xixi He outside the basin), Mabian He, Baoxing He, Long He, Jialing Jiang, and others.

### A. Nanya He

Nanya He is a tributary of the right bank of Dadu He. It flows into Dadu He west of the Shimian County seat. The entire river basin covers an area of 1,200 square kilometers and has a perennial flow rate of 50.6 cubic meters/second and an annual flow of about 1.6 billion cubic meters. The upper reaches above the fork of the river is a broad river valley basin with a gentle relative drop and a sparse population, ideal terrain for a key reservoir. The river channel from the fork of the river to the river mouth is 49.5 kilometers long and has a concentrated head of 1,714 meters and an average slope of 3.46 percent. It is suited to water diversion-type development. This section of the river is the primary segment planned for development of Nanya He.

Studies comparing many different development programs suggest a development program of six cascades (Yeqin, Liziping, Yaoheba, Nanguaqiao, Ximagu, and the side of Dadu He) with Yeqin as the key reservoir. This would involve mixed development at Yeqin and water diversion-type development of the other five cascades. Altogether, the six cascade power stations for the entire river would utilize a head of 1,774.6 meters and have a total installed generating capacity of 665 MW. During joint operation they would have a dry season output of 459.3 MW and generate 3.134 billion kWh of electricity yearly, but only 867 mu of cultivated land (all of it dry land) would have to be inundated and a population of 451 resettled. It is a superior medium-scale power source of which there are few in Sichuan Province and China.

All the cascades on Nanya He would focus on power generation, so the development tasks are simple and the scale of each cascade is appropriate. There would be substantial output during the dry season, and it is located near to Sichuan's main grids, so supplying power would be easy and the kinetic energy and economic indices are far superior to other medium-sized river basins. The key reservoir at Yeqin Power Station on Nanya He would have a perennial regulation capability and could increase dry season power output from the cascade power stations on Nanya He from 249 MW to 459.3 MW. If included in guaranteed output from the two power stations at Longzui and Tongjiezi on Dadu He, the total guaranteed output during the dry season would be about 480 MW, which is 2.7 times the guaranteed output from Longzui

Power Station. After all the cascade power stations on Nanya He are developed, they will be able to replace 575.2 MW in capacity and 3.992 billion kWh in power output from thermal power, which can save 1.4 million tons of coal each year. This will play an obvious role in increasing system peak capacity from hydropower during the dry season, reducing pressures on thermal power, and conserving coal.

### B. Wasi Gou

Wasi Gou is a tributary of the right bank of Dadu He. It is located in Kangding County in Garze Autonomous Prefecture. In its upper reaches, its northern source, Yala He, and southern source, Zheduo He, begin to form what is called Wasi Gou when they flow together at Kangding. It flows eastward to Wasi Township where it joins Dadu He. The river basin covers a total area of 1,564 square kilometers and has a perennial average flow rate of 47.1 cubic meters/second.

Precipitation is the main source of runoff in Wasi Gou. Runoff variations within a year and from year to year basically correspond to rainfall. Average runoff during the wettest and driest years, respectively, are 53 and 30.4 cubic meters/second, a rather small rate of variation. Runoff in Wasi Gou is relatively abundant during the dry season and is replenished mainly by glaciers and underground water. The smallest average monthly runoff during the dry season is about 17 cubic meters/second, about one-third the long-term average flow rate and far higher than other medium-sized river basins.

The section of the river channel on the trunk of Wasi Gou from Kangding to the mouth of Wasi Gou is 24.5 kilometers long. It has a natural head of 1,100 meters and an average slope of 4.4 percent, which is as high as 7 percent in some sections. This section has hydropower reserves of 450 MW, an average output of 18 MW per kilometer. This is the best concentration of hydropower resources on all of Sichuan's medium-sized and small rivers.

Besides supplying local power needs, development of Wasi Gou hydropower resources would mainly enable power to be transmitted to Sichuan's main grids. Given that most power from Wasi Gou would be transmitted outside to other areas, integration with the river's natural characteristics and development conditions suggests an initial plan for a three-cascade (Xindianzi, Ridi, and Lengzhuguan) development program. These three cascade power stations would have a total installed generating capacity of 400 MW with guaranteed output of 131 MW and yearly power generation of 2.411 billion kWh.

### C. Meigu He (including diversion of water from outside the basin from Xixi He)

Both Meigu He and nearby Xixi He are tributaries of the left bank of Jinsha Jiang. They are located in Meigu, Zhaojue and other counties of Liangshan Autonomous Prefecture. The source of Meigu He is at the southern foot of the Daliang Shan range, and it flows through

Jueluo, Bapu, Walu, Meigu Bridge, Liuhong, and other locations upstream from Shangtian Dam and into Jinsha Jiang. The entire river basin covers an area of 3,230 square kilometers and the perennial average flow rate at the river mouth is 65.5 cubic meters/second. The river channel of Meigu He from Weiqi Gou to the river mouth is 121 kilometers long. It has a head of 1,607 meters, a slope of 1.33 percent, and hydropower reserves of 640 MW. It is the main river segment for developing Meigu He hydropower. The section in the upper reaches from Weiqi Gou to Meigu Bridge has a river channel 68 kilometers long with a head of 634 meters and a slope of 0.93 percent. It is constricted and expanded by the terrain along its course and most of the river channel reverberates on alluvial strata shoals. The river valley is broad and shallow, forming a U-shape or steps, and the flow is relatively gentle. The two sections of the river from Weiqi Gou to Niuniuba and from Niuniuba to Meigu Bridge have slopes of 0.76 percent and 0.68 percent, respectively, terrain suitable for building regulation reservoirs. The lower segment from Meigu Bridge to the river mouth covers a river channel 53 kilometers long with a head of 973 meters and an average slope of 1.84 percent. The river pierces narrow gorges and has a concentrated head, which is extremely conducive to water diversion-type development.

The source of Xixi He is on Mogu Shan in southern Yuexi County. It flows from north to south through Yangmaozu, Bier, Zhaojue, and other locations in Zhaojue County and flows into Jinshan Jiang upstream from Duiping. The entire river basin covers an area of 2,858 square kilometers and has a perennial average flow rate of 61.4 cubic meters/second. The river channel of Xixi He from Yangmaozu to the river mouth is 135 kilometers long. It has a head of 1,778 meters, an average slope of 1.32 percent, and contains about 680 MW in hydropower reserves. It is the primary section of Xixi He for developing hydropower. The upper section from Yangmaozu to Guangming is a plateau and hilly region. The river valley is broad and the flow gentle, rather good conditions for reservoir construction. The section of the river in the lower reaches between Guangming and the river mouth flows through high mountains and narrow valleys. It has many shoals and flows fiercely, and the head is concentrated. The river channel is 81 kilometers long and has a head of 1,423 meters and a slope of 1.76 percent. Because communications, transport, construction, and other conditions below Guangming are unusually difficult, however, it would pose considerable problems for water diversion development along the river. While the distance between Guangming, 15 kilometers downstream from Zhaojue on Xixi He, and Meigu Bridge on Meigu He is only about 19 kilometers, the difference in head between the present surface of the two rivers is 590 meters, and Wupo He, a tributary of Meigu He, runs between them. These are favorable conditions for development extending beyond the river basin by diverting water from Xixi He to Meigu He. Communications are also convenient, so this offers a rather realistic and feasible route for integrated development of

Meigu He and Xixi He to accelerate development and utilization of hydropower resources.

On the basis of the natural conditions and development conditions of these rivers and after several on-site survey studies, the preliminary idea is to develop six cascades on Meigu He (Jueluo, Niuniuba, Waluo, Wajiji, Liuhong, and Pingtuo) and develop three cascades on the upper reaches of Xixi He (Kuyi, Wupo, and Meigu Bridge) and divert water from outside the river basin for a total of nine cascade power stations, including three reservoir cascades at Jueluo and Waluo on Meigu He and at Kuyi on Xixi He which would have rather good regulation capabilities. When all nine cascaded power stations on these two rivers are developed and go into joint operation, they would have a total installed generating capacity of 795 MW, guaranteed output of 570.2 MW, and yearly power output of 5.264 billion kWh.

Meigu He is located in the central part of Liangshan Yiru Autonomous Prefecture. It has excellent hydropower resource development conditions and convenient communications to outside areas. The conditions exist to make Liangshan Autonomous Prefecture an energy resource base and one of Sichuan Province's medium-scale hydropower station base areas. Development of Meigu He would play an important role in developing Panxi's abundant mineral resources, invigorating the national economy in Liangshan Autonomous Prefecture, and reducing the severe power shortage in Sichuan's main grids.

#### D. Mabian He

Mabian He is a tributary of the right bank of the lower reaches of Min Jiang. It flows mainly through Mabian, Muzhou, Qianwei, and other counties in Leshan Prefecture. Mabian He divides into southern and northern branches upstream from Lianghekou at the Mabian County seat. The southern branch is Gaozhuying He and the northern branch is Wahei He, the primary source. The two branches form the trunk of Mabian He after joining at Lianghekou. The river basin covers an area of 3,540 square kilometers and the perennial average flow rate at the river mouth is 138 cubic meters/second. The trunk and tributaries contain hydropower reserves of about 550 MW.

The main reason for developing hydropower resources on Mabian He is to meet increasing power needs for industrial and agricultural development in Leshan City and for developing Mabian Phosphorous Mine in its upper reaches. Preliminary plans call for a five or six cascade (Youle Bridge, Huogu, Zhouba, Huangdan, and Tanguanjiao) dike and dam development program on the trunk with a key reservoir at Guanmaozhou and downstream from there. A two cascade high head water diversion-type power station at Boluo and Waheikou is planned on Wahei He, the primary source, for matching development of Mabian Phosphorous Mine. Besides an installed generating capacity of 80 MW at Guanmaozhou Reservoir Power Station, all the power stations

for the other cascades would have installed generating capacities of 30 to 50 MW, which is suitable for raising capital locally for construction. The total installed generating capacity for the cascades on the trunk and tributaries would be about 350 MW, which would produce a guaranteed output of about 140 MW during joint operation and generate about 2.1 billion kWh of electricity annually.

#### E. Baoxing He

Baoxing He is the primary source river for Qingyi Jiang. Its source is the southern foot of Balang Shan in north Baoxing County. It flows from north to south, passing through Qiaoji, Baoxing, Lingguan, Tongtou, and Lushan and flows into Qingyi Jiang at Feixianguan. The river basin covers an area of 4,730 square kilometers. It has a perennial average flow rate of 159 cubic meters/second and contains 1,555 MW in hydropower resource reserves, over 60 percent of it on the trunk of Qingyi Jiang. The primary river segment in plans is from Qiaoji to Feixianguan. This section of the river is 109 kilometers long and has a natural head of 1,430 meters. It is the richest section of Qingyi Jiang in hydropower resources. From the two deltas of Baoxing He to Qiaoji, the river channel is 51 kilometers long, with a natural head of 1,030 meters and an average slope of over 2 percent; downstream from Lianghekou to Xiaoguanzi, the river channel is 13.2 kilometers long and has a head of 180 meters and an average slope of 1.36 percent, all of which are suitable for developing water diversion. Broad Mantan terrace is located in the river valley upstream in the area of Qiaoji, where the terrain is conducive to building a key reservoir.

The main reason for developing Baoxing He is power generation. Besides supplying power to the Ya'an region, it would mainly transmit power to Sichuan's main grids. On the basis of the river's natural conditions and after several studies, current plans call for a development program involving a mixed arrangement of six cascades (Qiaoji, Fengtongzhai, Yemaoping, Baoxing, Shangba, and Tongtouchang), with one cascade and key reservoir in the upper reaches, a four-cascade water diversion arrangement in the middle, and one mixed-type cascade in the lower reaches. The total installed generating capacity of the six cascade power stations would be 610 MW and they would have a guaranteed output of 300 MW during joint operation and generate 3.9 billion kWh of electricity annually.

#### F. Long He

Long He is a tributary of the southern bank of Chang Jiang. It passes through the Shizhu County seat and flows into Chang Jiang on the bank opposite the Fengdu County seat. The entire river basin covers an area of 2,180 square kilometers. The perennial average flow rate at the river mouth is 54.1 cubic meters/second and it contains hydropower resource reserves of 168 MW. The middle and upper reaches of Long He lie within Shizhu County and the lower reaches are in Fengdu County.

The river channel from Qiaotou Township in Shizhu County to the river mouth is 115 kilometers long. It has a natural head of 542 meters and an average slope of 0.47 percent. The river valley below Sifangshi is rather broad and the slope gentler. The river valley below Tiaodeng is steep and narrow and the head is concentrated. To develop hydropower and integrate with the need to provide irrigation water along the river and flood prevention in the area of the Shizhu County seat, preliminary plans call for an eight cascade development program for the section of the river from Qiaotou Township to the river mouth with a reservoir at Bajiaotan and seven water diversion-type power stations. Moving from upstream to downstream, the eight cascade power stations would be located at Sifangshi, Bajiaotan, Nanbin He, Shangjie, Tiaodeng He, Shibanshui, Yujiankou, and Jinzhutan. Together they would utilize a head of 500 meters and have a total installed generating capacity of 252.9 MW with a guaranteed output of 93.3 MW, and generate 1.026 billion kWh of electricity annually. Four cascades, Tiaodeng He (50 MW), Shibanshui (105 MW), Yujiankou (40 MW), and Jinzhutan (25 MW) would be medium-sized power stations. Bajiaotan Reservoir would be a key reservoir (22 MW). It is the controlling project for the entire river and would have a substantial effect on output from power stations downstream, so it is included among the medium-sized power stations.

#### G. Jialing Jiang

Jialing Jiang is located in the central part of the Sichuan Basin. It is a main tributary of the left bank of the upper reaches of Chang Jiang. Its source is at the southern foot of the Qinling range. It passes through Shaanxi and Gansu and then enters Sichuan, flowing southward from Guangyuan, Cangxi, Langzhong, Nanbu, Yilong, Feng'an, Nanchong, Wusheng, Hechuan, and other counties and cities to flow into Chang Jiang at Chongqing. The total length of the river is 1,120 kilometers. The river basin covers an area of 160,000 square kilometers, 70 percent of it within the borders of Sichuan. The perennial average flow rate at Beibei Station at the river mouth is 2,120 cubic meters/second and the yearly flow is 67 billion cubic meters. The trunk and tributaries of Jialing Jiang within Sichuan contain 10,510 MW in hydropower reserves, including a developable installed generating capacity of 5,500 MW. It is a major energy resource advantage in east Sichuan.

The planned river segment is the section between Cangxi and Hechuan in the middle reaches of Jialing Jiang. It is 500 kilometers long and flows through hilly central Sichuan. The area along both river banks is dense with farmland, cities, and towns, and has a dense population. Statistics for the 10 counties and cities along the river show it has over 7.4 million mu of cultivated land and a population of 9.16 million. Nanchong and Chongqing Prefectures in the middle and lower reaches have a relatively developed industrial economy. This is one of Sichuan Province's main agricultural, industrial, and commercial economy regions.

To accelerate the pace of development on Jialing Jiang, on the basis of comprehensive planning experience, studies call for retaining Tingzikou upstream from Cangxi on the trunk to regulate runoff and increase comprehensive utilization benefits in the downstream river section. Based on the principle of developing low dams and integrating power and shipping in the section from Cangxi downstream to Hechuan, a 13 cascade development program has been suggested. Moving from upstream to downstream, the cascades would be at Cangxi, Shaxichang, Jinyintai, Hongyanzi, Xinzheng, Jinxichang, Mahui, Fengyichang, Xiaolongmen, Qingju, Dongxiguan, Tongzihao, and Huatanzi. The total installed generating capacity would be 1,287.6 MW, with guaranteed output of 697 MW during joint operation and yearly power output of 7.58 billion kWh.

#### Footnotes

1. This article was written by Zhang Lianqing [1728 6647 1987] and checked and approved by Cai Chengzhong [5591 2110 1813].

#### Plan To Develop Medium-Sized Stations

906B0052C Beijing SHUILI FADIAN [WATER POWER] in Chinese No 2, 12 Feb 90 pp 19-21

[Article by the Energy Resource Office of the Sichuan Provincial Planning and Economics Commission: "Tentative Planning Ideas for Medium-Sized Hydropower Stations in Sichuan Province"]

[Text] Sichuan was one of China's first provinces to develop medium-scale hydropower. At the end of 1988, Sichuan Province had completed and placed into operation a total of nine medium-sized hydropower stations at Shizitan, Xiadong, Dahong He, Mofanggou second cascade, Yangxiuwan, Yuzi Xi first cascade, Nanya He third cascade, Gengda, and Caopo with a total installed generating capacity of 755.5 MW and design yearly output of 4.146 billion kWh.

Over the past several years, with substantial support from central authorities and efforts by the province, prefectures, and counties, there have been new developments in medium-sized hydropower station construction in Sichuan. There are a total of eight medium-sized hydropower stations now under construction in Sichuan at Mahui, Jiangkou, Anju, Luosichi, Sijiutan, Ganbao, Wenfeng, and Weituo with a planned installed generating capacity of 270.1 MW.

The total installed generating capacity from medium-sized hydropower already developed and now being developed in Sichuan is 1,025.6 MW, with yearly power output of 5.479 billion kWh. Still, these are just 6.7 percent and 6.4 percent, respectively, of developable medium-sized hydropower resource installed generating capacity and yearly power output, so over 90 percent is not yet developed and utilized. Moreover, it lags far behind the 11 percent of medium-sized hydropower resources already developed for China as a whole. Thus,

making full use of Sichuan's medium-sized hydropower resource advantages and further developing them will play an active and promoting role in alleviating Sichuan's electric power shortage and promoting economic development in all areas of Sichuan.

#### I. Tentative Planning Ideas for Developing Medium-Sized Hydropower Stations in Sichuan

Based on the goal of developing 10,000 MW in medium-scale hydropower in the "Medium-Term (1989-2000) Planning Program for Developing the Energy Resource Industry in China" formulated by the Ministry of Energy Resources, Sichuan Province should combine a focus on several large key hydropower stations (like Ertan, Tongjiezi, Baozhusi, Baobugou, etc.) with additional development of several medium-sized hydropower stations.

There are many locations in Sichuan Province which can be used to develop medium-sized hydropower stations. Questions involving integration with the requirements of economic development, rational deployment, and development according to schedules and groups are topics which deserve extensive study in Sichuan Province's electric power development plans. In conjunction with Sichuan's medium-scale hydropower resource conditions and the operation of already developed medium-scale hydropower, we should observe the following principles when planning deployments:

1. Be concerned with building and deploying key reservoir power stations which have specific regulation and storage capabilities. Reservoirs with regulation and storage capabilities should be used to increase guaranteed output of the power stations themselves and downstream cascade power stations for compensation and increasing the benefits of substitution for thermal power capacity.
2. Downstream from regulation reservoirs, focus on concentrating specific forces for sustained cascade development and try to form hydropower base areas as quickly as possible and foster comprehensive benefits from rivers for flood prevention, irrigation, water-borne shipping, and water supplies.
3. Focus on developing first medium-sized power stations in regions which are near load centers and which are capable of absorbing seasonal electric power.

In accordance with these principles, we feel that when planning deployments for development of medium-sized hydropower stations, it would be best to adopt a method which combines centralization and decentralization. Centralization means gradually forming hydropower base areas on the basis of tentative ideas for cascade development. Decentralization means dealing with power use needs locally to motivate local initiative.

On the basis of views developed from many studies by relevant departments in Sichuan Province over the past several years, Sichuan plans to concentrate forces to

develop 5,000 MW in medium-scale hydropower within the next 20 years. Preliminary arrangements call for building 2,000 MW in medium-scale hydropower prior to 2000 and completing an additional 3,000 MW by 2010. On the basis of this tentative idea, preliminary plans call for making these rivers the targets for focused development:

1. Nanya He: Focus on developing Yeqin (200 MW), Liziping (120 MW), and Yaoheba (123 MW) before 2000 and complete an additional 60 MW in cascade development by 2010.

2. Baoxing He: Focus on developing Tongtuo (60 MW) and Shangba (90 MW) before 2000 and complete an additional 380 MW in cascade development by 2010.

3. Long He: Focus on developing Tiaodeng He (25 MW) and Shibanshui (60 MW) before 2000 and complete an additional 87 MW in cascade development by 2010.

4. Mabian He: Focus on developing Huangdan (40 MW), Zhouba (50 MW), and Boluo (35 MW) before 2000 and complete an additional 192 MW in cascade development by 2010.

5. Meigu He: Focus on developing Liuhong (120 MW) and Wubo (100 MW) before 2000 and complete an additional 500 MW in cascade development by 2010.

6. Wasi Gou: Focus on developing Lengzhuguan (140 MW) and Ridi (150 MW) by 2000 and complete an additional 180 MW in cascade development by 2010.

7. Jialing Jiang and its tributaries: Focus on developing Dongxiguan (180 MW) and Zilanba (102 MW) by 2000 and complete an additional 800 MW in cascade development around 2010 on the trunk and some tributaries.

8. Min Jiang upper reaches: Focus on developing Taipingyi (260 MW), Shapai (30 MW), Sangping (25 MW) and Lixian (36 MW) by 2000 and continue to complete an additional 200 MW on the trunk and tributaries around 2010.

9. Qingyi Jiang and tributaries: Focus on developing Caoyutan (60 MW) and Yucheng (60 MW) by 2000 and continue to complete an additional 585 MW in cascade development around 2010.

10. Fu Jiang trunk and tributaries: Focus on developing Tongkou (36 MW), Mingtai (36 MW), and Fujinba (30 MW) by 2000 and continue with cascade development of an additional 757 MW around 2010.

Additional key development projects on other rivers prior to 2000 include Heng Jiang (25.2 MW), Xi He (40 MW), Ke He (45 MW), Mofanggou first cascade (30 MW), and Luo Jiang mouth (36 MW).

Medium-sized power stations to be constructed in conjunction with water conservancy projects prior to 2000 include Daqiao (60 MW) and Yuzui (75 MW).

## II. Countermeasures and Measures for Accelerating Development of Medium-Scale Hydropower

Countermeasures and measures for accelerating the development of medium-scale hydropower have been discussed in plans for medium-scale hydropower in Sichuan. The main points are:

1. Work more on strategic planning to develop Sichuan hydropower. Sichuan's energy advantage is hydropower and additional work on strategic planning for developing hydropower is an urgent task. This plan should draw on collective wisdom and absorb all useful ideas, and it should scientifically and realistically suggest principles and arrangements for developing hydropower to enable integrated development of large, medium, and small scales.

2. Take greater advantage of central and local initiative, combine development of large, medium, and small scales, and focus on medium-scale hydropower in the near term. Further implement the principle of raising capital to develop power and everyone developing power, encourage the raising of capital from many sources for joint construction of medium-scale hydropower.

3. Formulate preferential policies to encourage development of medium-sized hydropower stations. These policies should include tax and interest concessions, new prices for new power, wet and dry season peak-and-valley power prices, capital guidance, encouraging rolling development, and other aspects.

4. Open channels for raising capital. The greatest problem facing development of medium-scale hydropower now is a capital shortage, so we should continue to implement the principle of integrating higher and lower levels for joint investments to develop power. Given that Sichuan now faces a power shortage and is in extremely difficult financial straits, we should stick to the method of relying on support from central authorities above, opening up pathways below, and raising capital from many sources.

5. Be concerned with coordinating relationships among all areas. The process of building a hydropower station concerns many departments, so we should be concerned with handling the relationships between all areas well. This is also important work for accelerating hydropower construction. Questions concerning population resettlement, the ecological environment, water-borne shipping, timber floating, water conservancy, and other aspects should be handled according to stipulations in the Water Law, begin with the conditions in Sichuan Province, and put an end to unreasonable demands from all departments to avoid increasing the difficulty of hydropower construction.

6. Focus more on preparatory work for medium-sized power stations. River survey and planning work must be reinforced and plans which have been examined and approved should be used as a foundation for selecting

the best among several medium-sized power stations to prepare feasibility studies and preliminary designs. More funds for preparatory work should be raised to establish preparatory work funds.

7. Simplify examination and approval procedures. To meet the need to accelerate construction of medium-sized hydropower stations, we should make suitable reductions in the schedules for preparatory work. We propose that the state also make suitable relaxations in authority over examination and approval for medium-sized hydropower stations.

8. Establish hydropower development companies to promote cascade development. Several medium-sized hydropower development companies should be established to effectively carry out cascade development and rolling development of medium-sized hydropower stations. The state can give the companies greater authority and treatment in the area of developing medium-sized hydropower to achieve organic integration of responsibility, rights, and interests in hydropower development.

9. Formulate policies to encourage foreign businesses to come to Sichuan to develop hydropower. Encouraging foreign businesses to develop hydropower is not the same as extracting other mineral resources since it does not involve questions of plundering extraction and destruction of resources. The advantage of the renewable nature of utilizing hydropower resources is that it can attain the goal of promoting economic development. We should formulate preferential policies for utilizing foreign capital to develop hydropower, we should encourage the integration of hydropower development and mineral resource development, we should use hydropower to promote development and utilization of Sichuan's mineral resources, and we should use mineral resources as compensation for foreign investments in developing hydropower. We should strive to have relevant departments of the state assist Sichuan in locating preferential loans, and we should relax examination and approval to integrate Sichuan's power and minerals for use as export products in compensated trade.

The plan also pointed out in closing that the nucleus of readjusting the energy resource structure in Sichuan Province is to accelerate hydropower development and increase hydropower as a proportion of primary energy resources. Focusing on medium-scale hydropower development in the near term is the shortcut to accelerating hydropower development in Sichuan. However, Sichuan has not done sufficient research on plans and deployments for developing medium-scale hydropower and we have not worked hard enough on policies and measures in the area of building medium-sized hydropower stations. For this reason, we must continue to supplement and perfect our plans in the future, and our countermeasures and measures

should be continually readjusted and supplemented according to the conditions of plan implementation.

### **Guizhou Sees Good Prospects for Hydropower Development**

40100037D Beijing XINHUA in English 1519 GMT  
5 Mar 90

[Excerpt] [Passage omitted] Han Peichang, general engineer of the Guizhou Hydropower Industrial Department, said that last year the province's hydropower production totalled 4.15 billion kWh.

He said the province has built more than 2,300 dams to block nearly all of its rivers. They have a total installed capacity of 1.33 million kW.

In 1965, the province had only 10,000 kW of installed capacity and the annual hydropower production was only 40 billion kWh. In 1979, the province began to see rapid growth in hydropower construction.

Since 1985, Guizhou's hydropower generation has increased at an annual average rate of 12.1 percent.

The construction of two large hydropower stations—Tianshengqiao station on the South Panjiang River, with an installed capacity of 1.32 million kW, and Dongfeng station on the Wujiang River, with an installed capacity of 510,000 kW—will be completed in a few years.

Feasibility studies on the construction of other large stations (over 250,000 kW each) are under way.

Guizhou is especially rich in water resources. Some 18.5 million kW of water energy resources can be tapped within the province's boundaries.

Han said the state plans to build two hydropower bases in Guizhou in the drainage areas of the South and North Panjiang Rivers and the Wujiang River.

On the Wujiang alone, there are nine ideal station sites, of which eight are yet to be tapped. The Wujiangdu station, which started generating power in 1979, has an installed capacity of 630,000 kW.

Han said the province has tapped only 10 percent of its exploitable water energy resources.

He said that while building large stations, the province is paying equal attention to the construction of small stations (under 25,000 kW) which produce electricity mainly for rural families.

Presently, 90 percent of the province's 87 counties have stations of over 10,000-kW generating capacity.

Last year, small stations produced 962 million kWh of electricity for 48 percent of the province's rural families.

### Work on Supercritical Shidongkou Plant Enters Overall Installation Stage

906B0054A Shanghai JIEFANG RIBAO in Chinese  
28 Feb 90 p 1

[Article by Zhang Zhiyuan [1728 1807 6678]]

[Text] China's first supercritical high-capacity coal-fired power plant—the Shanghai Shidongkou No 2 Plant—has now entered its overall installation stage.

Yesterday morning, a joint meeting was called by the Shanghai Municipal People's Government and the Huaneng Corp. to be held at the construction site. The purpose of the meeting was to mobilize the personnel in an effort to accelerate the Shidongkou construction project. Attendants at the meeting included more than 600 people representing the city government and various departments associated with the design, construction and equipment manufacturing for municipal electric power development. A key resolution of the meeting, which was held on the open field south of the three 245-m-tall chimneys of the power plant, was to complete the first 600-MW generator units for full-scale operation by 15 October of next year.

Construction of the Shanghai Shidongkou No 2 Power Plant, which is one of China's critical energy development projects, is funded jointly by the Huaneng International Power Development Co. and the Shanghai Municipal People's Government. The plant is China's first high-capacity, supercritical power plant built by Chinese engineers and technicians using imported equipment and technologies. The first stage of the project includes construction of two 600-MW generator units with room for expansion of two additional 600-MW units. The foundation of the first-stage construction was laid in January 1988, and actual construction began 5 months later. By January of this year, a cumulative sum of 591 million yuan had been invested in the project. At the present time, the main building, the boiler room, the gas turbine room as well as the purification system and electrical system are already in the final installation stage. Once the first stage is completed, all the power generated from the two 600-MW units will be used to relieve the power shortage situation in Shanghai Municipality; the additional power supply will play an important role in promoting the city's agricultural and industrial production and in improving the living standards of city residents.

Speaking for the Shanghai city council, the city government and Mayor Zhu Rongji, deputy secretary of the city council and assistant Mayor Huang Ju expressed his thanks to the central government and the Huaneng Corp. for their support, and gave encouragement to all personnel connected with the construction project. Departing from the prepared 8-page speech, he summarized his talk in the following four main points: 1) maintain project schedule; 2) quality of work must be emphasized as well as speed; 3) expenditures must be

strictly controlled; and 4) adopt foreign technologies and advanced management skills.

In addition, general manager of the Huaneng Group, Wang Chuanjian, and general manager of the Huaneng International Power Development Co., Lang Chenwei, also spoke at the meeting. They pointed out the important economic impact of the Shidongkou project: failure to meet the construction schedule will cost the state US\$84,000 per day or \$2.5 million per month. They urged everyone to put in extra effort in case the project should fall behind schedule.

### Work in Full Swing on Liaoning Expansion Project

906B0054B Shenyang LIAONING RIBAO in Chinese  
9 Jan 90 p 1

[Article by Zhu Fengqi [2612 7364 6386], Liu Jingkui [0491 2529 1145], and Ma Wenke [7456 2429 4430]]

[Text] On New Year's Eve, under the direction of chief commander of the Liaoning Power Plant expansion project, Gu Peide, nearly 100 welding technicians climbed up the 58-m-tall high-temperature, high-pressure boiler to inspect more than 13,000 weld joints for leaks under an air pressure of 3 kg/cm<sup>2</sup>. At this point in time, the boiler of the No 1 generator unit has already passed the wind-pressure test, which is used in place of the water-pressure test in winter season. The successful passing of the wind-pressure test implies that the boiler will meet the required water-pressure conditions; it also indicates that installation of the No 1 generator unit is 50 percent complete. Now the boiler is ready for insulation work; it is expected that the generator unit will become operational this year, ahead of the scheduled date.

Located on the east bank of the Zhangdang river below Bailong Mountain, the second stage of the Liaoning Power Plant expansion project is one of the key engineering projects of Liaoning Province. Ground was broken for the project in June 1988; when completed, the expanded power plant will have two 200-MW generator units with an annual capacity of 2.4 billion kW-hr. The governor of Liaoning Province, Li Changqun, considered this to be an extremely important project; he pointed out that completion of the second-stage expansion project will play a critical role in relieving the power shortage situation in Liaoning Province.

At the construction site, thousands of workers from the No 1 Engineering Co. of the Northeast Power Administration Bureau devoted their days and nights to the project. Happy with the rapid progress being made on the project, Gu Peide told reporters that if funding and supplies for the project continue as planned, it is virtually certain that the two generator units will be fully operational this year. The additional power generated will be 1.2 billion kW-hr, which translates into 3.6 billion yuan in economic benefits.

## THERMAL POWER

**Construction Begins on 300MW Nanjing Plant**  
*40100036B Beijing XINHUA in English 1509 GMT*  
*1 Mar 90*

[Text] Nanjing, March 1 (XINHUA)—Construction of the Huaneng Nanjing Electric Power Plant, one of the country's major energy projects this year, started today in Nanjing, the capital of east China's Jiangsu Province.

The project will include two generating units, each with generating capacity of 300,000 kW, which, along with other major equipment for the project, will be imported from the Soviet Union.

Jointly funded by the Huaneng International Power Development Corporation and Nanjing City, the project will cost 1.5 billion yuan (319 million U.S. dollars).

The equipment to be imported from the Soviet Union will be financed by barter trade and repair services of Soviet ships.

The project is expected to generate 3.4 billion kWh of electricity annually when it is completed at the end of 1992.

### **Future of Offshore Oil Industry Said 'Rosy'**

40100037B Beijing CHINA DAILY in English  
26 Feb 90 p 2

[By staff reporter Xu Yuanchao]

[Text] China is predicting a rosy future for its offshore oil industry, with seven new offshore fields due to start operation over the next 3 years.

The new fields will have an annual production capacity of 5 million tons of crude oil and 1.2 billion cubic metres of natural gas by 1992, according to an official of the China National Offshore Oil Corporation (CNOOC).

The Bozhong 34-2/4 oil field, a Sino-Japanese co-operative project on the Bohai Sea in East China, will go into operation in May. The Hui Zhou 21-1 oil field, developed by Chinese, U.S. and Italian firms at the Pearl River mouth basin, will start operation in August.

The two will have an annual production capacity of 1.5 million tons in total.

Another two, scheduled to go into production next year, are the Hui Zhou 26-1, a Sino-U.S.-Italian co-operative project, and the Lufeng 22-1, a Sino-U.S. co-operative project.

In 1992, the remaining three oil fields run by Chinese companies will go into operation. They will include the Jin Zhou 20-2 gas field in Liaodong Bay, the Suizhong 36-1 oil field and the Wei 11-4 oil field in the Beibu Gulf in the South China Sea.

The official said CNOOC plans to increase its offshore oil output by 11 percent this year to 1 million tons.

The country produced a total of 963 million barrels of crude oil last year, an increase of 4.2 million barrels over 1988.

The oil industry is, however, seeing a decline in its annual rate of production as many of the old onshore fields that China has relied on for so long, become depleted.

Though there will not be a big increase in this year's offshore production, China is looking to discoveries of more new reserves to boost its declining oil production.

CNOOC will lay down 22,600 kilometres of seismic lines and strike 18 test wells on the contract area in co-operation with foreign oil firms.

The official said CNOOC has submitted a report to the State Council for approval for opening the East China Sea to foreign oil companies.

"It is necessary and possible in the current situation. If this report is approved by the State, the East China Sea will be opened for international bids," he said.

He said CNOOC also has plans to produce 3 million tons of offshore oil by 1991, 5 million tons by 1992 and 8 million tons by 1995.

### **Henan's Puyang Becoming Boom Town**

40100037C Beijing XINHUA in English 1232 GMT  
2 Mar 90

[Text] Zhengzhou, March 2 (XINHUA)—The discovery of oil reserves 5 years ago in Puyang, Henan Province, has made this rural town a booming oil industrial city.

The city, where the Zhongyuan (central China) oil field is located, has 1,200 wells turning out 49 million bbl of oil and 1.2 billion cu m of natural gas a year. It is now the fourth-largest oil and second-largest natural gas production base in the country.

Located on the lower reaches of the Yellow River, Puyang was one of the birthplaces of the Chinese nation but it used to be one of the poorest areas in China.

The former country town is being developed into a city with a population of 2.8 million and encompassing five counties and a district.

The city has 512 small petrochemical works, and machinery, light and textile factories.

It is learned that a large chemical works able to turn out 300,000 tons of synthetic ammonia and 520,000 tons of urea is scheduled to go into production this year, and preparations are under way to build a 140,000-ton ethylene project.

The development of industry has led to the accumulation of funds to improve farming conditions, according to a city official.

The local grain output has been rising for 5 years running and the city is now able to feed all its residents.

### **Oil Discovered in Turpan Basin**

40100037A Beijing XINHUA in English 1435 GMT 4  
Mar 90

[Text] Urumqi, March 4 (XINHUA)—After 3 years' effort, petroleum has been discovered in the Turpan Depression in the Xinjiang Uygur Autonomous Region in northwest China.

Commercially exploitable levels of crude oil have gushed from five of the test wells, and it is initially estimated that the oil-bearing area covers 17 square kilometers.

Prospecting is still under way.

**Talks Under Way With USSR To Import Two Nuclear Reactors**

40100036C Beijing XINHUA in English 1310 GMT  
14 Mar 90

[Text] Beijing, March 14 (XINHUA)—Huang Yicheng, minister of energy resources, said here today that China plans to build another nuclear power station with a capacity of 2 million kilowatts in northeast China's Liaoning Province.

The minister said negotiations between China and the Soviet Union are well under way to import two nuclear reactors, each with a capacity of 1 million kilowatts, to be installed at the Liaoning nuclear power station.

Huang explained that the two nuclear reactors to be imported from the Soviet Union will be of a different type from that of the Chernobyl nuclear power station in the Soviet Union and much safer.

According to China's energy development plan, nuclear power stations with a total capacity of 6 million kilowatts will be built. The two nuclear power stations now under construction at Daya Bay in Guangdong Province and Qinshan in Zhejiang Province only have a total capacity of 2.2 million kilowatts.

Besides the second phase of the Qinshan nuclear power station, China is preparing for the construction of Liaoning nuclear power station which will be located in the coastal area near Jinzhou City.

## Status, Developmental Strategy for Solar Photovoltaic Generation

906B0041A Chongqing XIN NENGYUAN [NEW ENERGY SOURCES] in Chinese 5 Jan 90 pp 1-3

[Article by Cui Rongqiang [1508 1369 1730] and Yang Jinhuan [2799 6855 3562] of Xian Jiaotong University: "Status and Developmental Strategy for Solar Photovoltaic Power Generation in China"]

### [Text] Abstract:

This paper analyzes the current status of solar photovoltaic power generation in China. It is believed there is a solid domestic foundation and that China is facing a rapidly growing demand. The solar photovoltaic power generation industry is at a new turning point. The paper also discusses existing problems and offers some recommendations for future development.

In recent years, the photovoltaic-power-generation (solar-cell) industry has made significant progress. Since solar cells were used for the first time as the power source for China's second satellite in 1972, they have been used in a variety of applications on earth, such as power supplies for navigation lights, railroad signals and communications. After over a decade of effort, we have made considerable progress in space and on earth. A complete photovoltaic industry, including manufacturing, applications, development and research, has taken shape in China. However, compared to other countries, we have not paid sufficient attention to photovoltaic power generation as a high-technology industry. The following is a discussion of the status, existing problems and developmental strategy of photovoltaic power generation in China.

## I. Status of Photovoltaic Power Generation in China

### 1. China's Solar Cell Production Capability Is at World-Class Level

According to statistics, the total worldwide output of solar cell devices in 1988 was 35 MW (megawatts). Since 1985, seven factories in China have imported solar-cell production lines. The original eight solar plants also imported some production facilities. Hence, China is capable of producing more than 4.5 MW of single-crystal, polycrystalline and amorphous silicon solar cells. The quality is comparable to the 1980's world level. After these lines are put in production, our annual capacity will rank third in the world, next to Japan and the United States. It will become a 200 million yuan per year industry.

### 2. The Decline of Solar-Cell Cost Is Slowing Down

Due to improvements in materials, structures and techniques, the cost of solar cells has been dropping, creating an excellent opportunity to expand their range of applications. Solar-cell devices used to cost over 100 yuan per peak watt in the late 1970's. Last year, it dropped to 30-40 yuan/peak watt (single-crystal), and the cost of

amorphous silicon solar cells was approximately 21-23 yuan/peak watt. Recently, due to inflation and rising material costs, the decline is slowing down and sometimes, the cost even goes up. It is estimated that the cost this year is going to be close to that last year. However, the actual cost has dropped somewhat.

### 3. A Powerful Research Team Has Been Formed

Over 10 research institutes and more than 20 higher-learning institutions are engaged in solar-cell research and have resulted in a large number of technical achievements. Some of them have reached or are close to world-class level. For instance, the efficiency of the polycrystalline-silicon solar cell developed by the Beijing Institute of Nonferrous Metals and the efficiency of the high-efficiency single-crystal silicon solar cell developed at the Research Institute 1418 have reached 19.2 percent. The GaAs cell developed by the Shanghai Institute of Metallurgy and Xinyu Power Supply Company has a better than 20 percent efficiency. The short-pulse solar-cell performance tester developed by Xian Jiaotong University was given a gold medal at the 1988 international invention exhibit in Beijing.

### 4. Various Applications Are in Place

After years of effort, solar photovoltaic power generation has been established to a considerable scale. By 1988, the entire country had 0.7 MW of solar-cell facilities. A great deal of experience has been accumulated in the design, development, operation, testing and maintenance of small, independent solar-cell power-generation systems.

In recent years, because the number of solar cells produced is rapidly increasing and their cost is steadily dropping, and because our national economy is growing and the living standard is rising, the range of applications of solar cells is also expanding. Rapid development is experienced in areas where a large number of solar cells are required, such as unmanned relay stations, photovoltaic water-pumping stations, and rural household power supplies. Particularly in rural household power-supply systems, a complete photovoltaic power-generation system which provides the minimum amount of power for lighting and black-and-white television reception only costs about 1,000 yuan. Relatively rich farmers can afford it. Moreover, the system is convenient, safe and reliable. Therefore, it is being promoted in many areas and the scope of applications is expanding.

In conclusion, the domestic photovoltaic power-generation industry has a solid foundation. At the same time, it is facing a rapidly growing demand. It is at a turning point.

## II. Existing Problems in Photovoltaic Power Generation

Despite the fact that China's photovoltaic power-generation industry is facing its biggest challenge and the

opportunity for growth is excellent, there are nonetheless many shortcomings that we cannot optimistically overlook.

### **1. Actual Output of Solar-Cell Devices Is Still Not Sufficiently Large**

Although China ranks very high in terms of production capacity for solar-cell devices, due to various reasons such as production management, marketing and sales, and supply of raw materials, the actual output of solar-cell devices in 1988 was approximately 0.3 MW, which is less than one-fifteenth of its production capacity. Furthermore, in some cases the quality is unstable.

### **2. Overall Level of Research Is Low**

Because of the lack of a central organization and shortage of research funding, research efforts carried out at different places are frequently redundant at a low level. The gap between the domestic level and the advanced world-class level is widening.

For instance, in the area of high-efficiency solar cells, which reflects the academic level, the conversion efficiency of the focused-beam recombination cell developed by Sandia Lab. has reached 31 percent last year, nearly one-third higher than the best solar cell developed in China. The efficiency of some novel thin-film cells (such as the selenium-indium-copper cell), which has been widely studied in recent years, is approaching 11.1 percent in other countries. China has just started in this area.

There is a great gap in the scale-up and applied technology of solar-cell power-generation systems as well. Other countries have built many experimental power plants. Several years ago, the United States constructed a 6.5 MW power plant parallel to the power grid, and a 50 MW solar power plant is under construction. China is still at a stage of building small and independent power-generation systems. The maximum capacity is 10 kW. There is no experimental power plant integrated into the grid.

### **3. Products Need Immediate Improvement**

Although photovoltaic power-generation systems are being promoted in many areas, some systems do not operate satisfactorily. Obviously, some systems have not been designed well. Most products are not standardized and serialized. We have not established a design standard for solar-cell systems that is generally considered to be mature and suitable for use in China. The quality of certain accessories (such as controllers, dc-to-ac inverters, storage batteries, dc lighting, etc.) is poor, which affects the reputation of solar-cell products. Many solar-cell-related products are still yet to be developed.

## **III. Recommendations for the Development of the Photovoltaic Industry in the Eighth 5-Year Plan**

### **1. Pay Attention to the Strategic Role of Photovoltaic Power Generation in the Electric-Power-Generation Industry in China**

Fossil fuel is being depleted on earth. Regenerative and non-polluting energy sources will play a more significant role. Photovoltaic power generation has advantages such as safety, reliability, ease of use, simple maintenance, long life (20-30 years), no moving parts, durability, no fuel required, and freedom from pollution. It is especially suitable for remote areas with no electricity service.

The major obstacle in promoting solar-cell power generation is cost: it requires a large initial investment. In spite of this problem, it is competitive with diesel-powered generators in some areas. The cost of solar cells is still dropping every year. The DOE (U.S. Department of Energy) 5-year photovoltaic-development plan for 1987-1991 projects that the cost of photovoltaic power generation can be reduced to \$0.12 per kWh by early 1990 and will go down to \$0.06 per kWh by the beginning of the next century. By then, photovoltaic power will be competitive with the public power grid in many areas.

China spans a wide territory and the coverage of our power grid is low. It will not be possible to link many remote villages and mountain sites to the power grid for quite a long time to come. Photovoltaic power generation is an effective way to solve this problem in those areas. It is expected that solar cells will be the way to provide electricity to counties without power and will play an important role in improving the production and living conditions of farmers and ranchers in remote areas.

### **2. Have Centralized Leadership as Soon as Possible**

In the past, certain ministries and commissions have encouraged the development of new energy sources and provided active support. However, due to a lack of a centralized leadership, the efforts were scattered. Let us reorganize the structure and form a lead organization to formulate and implement near- and long-term photovoltaic-development plans. This lead organization will have an overall responsibility to coordinate the research, production, development, quality control, personnel training and international cooperation activities associated with the national photovoltaic industry to bring it into a new era.

### **3. Identify Key Technical Projects and Increase Research Funding**

Several tens of millions of dollars have been spent on photovoltaic research in the United States. Some Western European countries are increasing funding for photovoltaic research. For example, the FRG is spending 100 million marks on photovoltaic projects.

Even India is spending over US\$10 million in research on new energy sources. The funding for photovoltaic research in China, however, is less than 1 million yuan in the Seventh 5-Year Plan. This shortage of funds has seriously affected research activities and widened the gap between China and the rest of the world. It is recommended that photovoltaic power generation be set aside as an independent item in the Eighth 5-Year Plan and be given more money to allow research activities in photovoltaic power generation to develop.

#### **4. Organize Manufacturers To Promote the Production and Use of Solar Cells**

Based on the actual situation in China, we must do the following things in order to turn potential production capacity into high-volume photovoltaic products:

- (1) Imported production lines must be digested, absorbed and technically transformed to ensure steady productivity and reliable quality.
- (2) Produce solar-cell sealing materials (such as tempered glass, EVA gel and Tedlar film) domestically as soon as possible to ensure the supply of raw materials.
- (3) Encourage the mass production of low-cost polycrystalline-silicon solar cells based on the accomplishments achieved in the Sixth and Seventh 5-Year Plans.
- (4) Combine key technical programs with imported amorphous silicon solar-cell production lines to improve the efficiency and stability of amorphous silicon solar cells.
- (5) The key to promotion of solar cells is applications. Existing photovoltaic applications must be improved and perfected. New applications will be further developed to meet various needs.
- (6) Organize other industries to supply high-quality, reliable, high-efficiency, reasonably priced accessories.
- (7) Establish a powerful test center to conduct research on quality monitoring and test standardization.

A manufacturing group thus organized can reliably ensure the output and quality of photovoltaic devices it produces. It will also be competitive in price. With appropriate application systems, it not only can meet our growing domestic demands but also has the ability to penetrate the international market to bring in hard currency.

#### **5. Implement Preferential Policy**

Developing new energy sources is an important measure toward solving the energy crisis. In order to encourage the development of new energy sources, many nations are offering support in the form of financial subsidies or a reduction of tariff. We are only providing some subsidies to farmers in some areas who purchase new energy equipment. In recent years, in order to raise more revenue, the authorities have changed the tax rate for solar cells from the 5-percent category as for semiconductors to the 12-percent category as for storage batteries. Thus, its cost goes up, which affects its development. We hope the relevant department will take measures to provide preferential treatments for solar-cell devices.

#### **6. Stop Further Imports**

China has already imported enough solar-cell production capacity to bring it to third place in the world. In the near term, it will be hard to realize the full economic benefits of that capacity. Some facilities are idle and capital investment is wasted. Some organizations are still planning to import more production lines; that may create a bigger waste. We recommend that the authorities take immediate action to stop the import of solar-cell production lines in the near future, unless for industries making products for export only.

We strongly believe that with continuing research, photovoltaic solar cells will make a further contribution to the material and cultural aspects of life. Someday, wherever the sun shines there will be electric power.

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